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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVI.—No. 388.

THE B.T.K. SECONDARY BATTERIES.

WE cannot help thinking that but few people are well informed even in the most elementary details concerning storage batteries, and that these cells, in the eyes of the multitude, are still very mysterious objects, behaving themselves most strangely and playing tricks which cannot be foreseen or afterwards accounted for.

In our issue of last week we notified to our readers that the report of Prof. George Forbes on the B.T.K. batteries had been issued and that we intended going more fully into the matter in a future number. Four years ago we were accustomed to such publications as that to be found in our other pages, but now, after hearing papers on the subject read and discussed at the meetings of various societies, and after so much has been published in our own columns and in those of our contemporaries, we insist that such illogical reasoning as is shown in this report is, to say the least of it, as unexpected as it is unscientific—not a credit to the author.

No one at the present stage of our knowledge would think of determining, for commercial purposes, the efficiency of a single cell and therefrom deduct conclusions as to what a number can perform. Prof. Forbes was supplied with a series of 18 cells to experiment upon, and it would have cost him but little more trouble had he applied for such a number as is likely to be used in an installation of modern incandescent lamps—requiring say 60 to 100 volts. This would have been the more desirable since he says "it is the only method which gives a satisfactory idea of their action in practice, as it is usual to employ a number of cells in series."

Considering that the experiments—according to the pamphlet before us—were of a fortnight's duration, it would, at first sight, appear odd that the employés of the Consolidated Electric Company were invited "to supply him with a charging current which they preferred." This particular rate of charge was, however, doubtless found to be the best to yield the greatest possible return; nevertheless, the public would have appreciated other data, such as the efficiency at lower rates and the results at the highest rates of charge and discharge, because in so many instances of the commercial application of secondary batteries it is not so much a question of efficiency as a high rate with a constant potential for a given time, if only for an hour or two. Such data would have supplied a useful addition to the knowledge now at our command.

On page 5, to which we referred last week, we find that several (how many?) cells were not in perfect order and lost their E.M.F. entirely.

Had Prof. Forbes tested the electromotive force of each cell separately during the experiments, he would then have been able, by weeding them out one by one, to give the remainder *that chance* which it was on the face of this report intended they should have, and to ascertain with greater precision their efficiency.

It is not likely that the experimenter was supplied with batteries at random, and it is therefore to be regretted that no mention is made as to the probable cause of loss of electromotive force in several cells, nor as to the period at which this mishap took place, for surely with so small a number as 18 any disturbance must have been instantly observed with the perfectly calibrated measuring instruments employed. Taking the E.M.F. of a cell as 2 volts, it is not too much to assume that if several cells of a series, representing at the highest value say 36 volts, dropped off, the fluctuations during the Professor's 960 observations should have been noticeable, and the better cells of the few left *might* have given even higher results.

Much is said in this most unsatisfactory report about ampère hours, and nothing about E.M.F. We should have liked to have seen the electromotive force readings tabulated and the *rate* of discharge given.

Prof. Forbes says he obtained a total of 263·2 ampère hours when the E.M.F. had fallen "very low indeed." This is not scientific, nor even useful.

The "practical output" was finished in seven hours, by the end of which time the E.M.F. had fallen 18 per cent., and the output was 132·01 (note the ·01 !) ampère hours. Now a fall of 18 per cent., whatever the real electromotive force may have measured, is a serious matter, and the "practical output" should not be taken after a fall of more than 10 per cent.

Assuming that such a fall in the potential were admissible, and that the "practical output" of a battery containing 57 lbs. 14¼ oz. of lead plates was 132·01 ampère hours, and that more than a total of 263·2 ampère hours had been put in—as must have been the case, when we see that the grand total was 263·2 ampère hours when the E.M.F. had fallen "very low indeed"—then the ampère hour efficiency could not have been more than $\frac{132\cdot01}{263\cdot2} = 50$ per cent., and the true commercial efficiency stated on p. 4 to be 60·23 per cent. should, in this case, read something like 35 per cent.

Prof. Forbes even takes the trouble to show that the useful output is 2·3 ampère hours per lb. weight of plates including the supports and terminals of the plates, and he makes it a special point that reports are often made of the output of storage batteries "in which the weight of active material (the lead salts) is alone included, and the lead support of the plates is omitted; this being misleading." We know of a battery which, in rough daily work, gives over 5 ampère hours per lb. of lead inclusive of supports and terminals, and that without bulging or mysteriously dropping its electromotive force after many months of hard wear. We venture to think that Prof. Forbes is ill advised in giving reports of an unmeaning and general character when such are liable to be printed and circulated. The Professor's opinion is, "that these cells are good, and that their performance would have been better if they had been better treated before being placed in my hands." We are inclined to think that the efficiencies given could hardly have been much improved, even with the best of secondary batteries, and the final apology is quite unnecessary under the circumstances.

The single charge and discharge of another more perfect battery of 18 cells under "favourable conditions," in which the E.M.F. was allowed to drop 14 per cent. with only 193·48 ampère hours is of no value whatever, and that trouble might have been saved. There is more to which we might take objection, but enough has been said for the present. A second report on these batteries by M. E. Dumas is not worth criticising.

In conclusion we must in all fairness add that we have reason to believe if more care and attention had been paid to the development of the idea, and the manufacture of the apparatus, an efficient secondary battery might have been made on the B.T.K. system.

THEORETICAL AND EXPERIMENTAL RESEARCHES ON THE SECONDARY GENERATORS OF GAULARD AND GIBBS.

By PROFESSOR GALILEO FERRARIS.

(Continued from page 368.)

The resistance r, like r', is obtained by means of a coil of thick nickel silver double coiled with wide spirals on a large frame of wooden squares. To avoid effects of self induction the wire was coiled in such a manner that the current might descend by the odd turns and re-ascend by the even ones. The entire coil had a resistance of about 16 ohms. To vary conveniently the resistance, r without interrupting the circuit, the commutator, C, a, b, in place of having, as for simplicity's sake it is shown in the figure, only two contacts, a and b, had 10; the first of which communicated, like a of the figure, with the bit, p, of the secondary generator; the others communicated by means of as many copper wires with different points of the spiral, r. The small variations of the resistance, r, are obtained by means of a copper wire, d, soldered at e to the beginning of the spiral, r, the end, c, of which could be made to run along the spiral and be fixed in any position whatever.

The resistance of the conductor, C, b, r, F, 1, O, β, H, q, was measured immediately after each experiment by means of a bridge arranged for the purpose and connected with the points, C and q. Quickly afterwards there was measured with the same bridge the resistance of the complete secondary circuit at the points, a and o.

The following is the order in which I proceeded in each experiment. I put in the secondary circuit a certain measured resistance, r', the plug of the commutator, a, β, was placed at a, and contact was made with the commutator, C, a, b, at a. The commutator, o, m, n, of the calorimeter was arranged with its contact at n, so as to exclude the calorimeter and insert in its stead in the circuit the equal resistance, R. This being done, contact was made with the commutator, A, B, Y, at B, thus causing the current to arrive in the laboratory. The primary current passed then through B, M, S, C, a, p, G, q, D, X, Z, and thus set in action the secondary generator, G, producing a secondary current setting out from s and passing through r', L, a, O, n, R, V, 1, t. An observer read off the deviations of the electro-dynamometer, S, and of the electrometer, E, and registered them. Meanwhile another observer read off the temperature of the calorimeter.

At a signal from the first observer the second turned the commutator, o, m, n, of the calorimeter, making contact at m, and sending the secondary current, by m, 2, into the calorimeter.

After a minute, at a second signal, the observer appointed to the calorimeter turned back the commutator to n, and read off the new temperature. During the observations an assistant kept in motion the spiral of the calorimeter to renew the water in contact with the wire and render the temperature uniform. Thus was conducted the first part of the experiment.

The commutator, A, B, Y, being placed at the contact, Y, to exclude the laboratory from the circuit, and to be able to manage the commutators without danger, the plug of the commutator, a, β, was turned from a and placed at β, and the commutator, C, a, b, was turned so as to withdraw C from a and to establish a contact between a and b. The commutator, A, B, Y, was then turned to the contact, B, and thus the current was allowed to re-enter. The primary current then traversed the cuircuit, B, M, S, C, b, r, F, 1, V, R, n, o, β, H, q, D, Z, without passing through the secondary generator, but passing instead through the variable resistance, r, and through the resistance, R, of the calorimetric apparatus. The indications of the electrodynamometer, S, and of the electrometer, E, are then, in general, different from those of the first part of the experiment, but the variation of the deviation of the electro-dynamometer, S, always very small, are immediately connected by the observer attached to the electro-dynamometer, who employs for this purpose another electro-dynamometer and the regulator of the exciting current. And the deviation of the electrometer, which in general varies notably, is reduced to the primitive value, which was found in the first experiment, by varying the resistance, r, tentatively. When the electrometer and the electro-dynamometer give constant indications, equal to those of the first experiment, the commutator, o, m, n, is turned, sending thus the primary current into the calorimeter.

As in the former experiment, a minute is then allowed to elapse, after which, at a signal from the observer posted at the electrometer, the calorimeter is anew cut off from the circuit, and the resistance, R, substituted, the rise of temperature being read off on the thermometer.

Immediately when the experiment is finished the laboratory is again shut off from the circuit by means of the commutator, A, B, Y; the resistance bridge is attached to the points, C and q, the wire, D, is detached as an additional precaution, and the resistance of the conductor, C, b, r, F, 1, O, β, q, is measured, which in the second experiment was substituted for the secondary generator.

Finally the resistance of the secondary circuit is measured.

SEC. 8.—*Results of the experiments.*

I place together here below the principal data relating to the secondary generator on which the measurements have been effected, their results and the observations belonging to them.

Data relating to the secondary generator.—The secondary generator used is one of those which Gaulard destined to absorb and transform an energy of about 1·8 horse-power.

It has the dimensions indicated in the table of M. Uzel's experiments by the name of the *great column*, from which it differs merely in the construction of the iron core. Whilst in M. Uzel's experiments the core is entirely made of a bundle of iron wires, that of the generator with which I made my calorimetric measurements is made of a cylindrical rod of wood covered with a layer of iron wire about four millimetres in thickness. The principal data concerning this generator are the following :—

Number of discs of primary spiral	455
" " secondary spiral	455
Diameter of the discs	114 mm.
Do. of central aperture ...	54 "
Thickness of copper discs ...	0·25 "
Height of column...	610 "
Total weight of copper discs	18,280 grms.
Total weight of apparatus about ...	20 kilos.
Number of equal parts into which the secondary spiral is divided ...	4
Resistance of primary spiral at 13° C.	0·276 ohm.
Resistance of secondary spiral at mean temperature when the four parts are connected in a simple circuit	0·285 "
Strength of primary current with which the apparatus is intended to work habitually and with which it worked during the experiments, about	12 ampères.

In all the experiments the four parts into which the secondary spiral can be divided were connected in a simple circuit in series. As the calorimeter presented a considerable resistance, if the secondary spirals had been connected in a multiple circuit in quantity, the experiments would have been carried on under conditions very different from those in which Gaulard is accustomed to let his apparatus act.

In the first seven experiments registered in the following table the spiral of the calorimeter had a resistance of 4·18 ohm ; in the following experiments this was exchanged for another of a resistance = 3·97 ohms.

The Siemens dynamo which supplied the primary current made on an average 670 turns per minute during the experiments. The coils of the machine were 24, which made 16,080 inversions of current per minute, therefore 268 per second. The machine was driven, as already mentioned, by a steam engine of more than 140 horse-power, which simultaneously set other machinery in motion. This gave much room for sensible variations in velocity which could not be completely avoided and of which account must be taken.

In the measures comprised in the following table the value of the resistance, r', of the secondary circuit was made to vary from experiment to experiment. The first experiment (No. 1) was made with the secondary circuit containing only the resistance of the induced spiral, of the calorimeter and of the connecting wires. The last experiment (No. 14) was made with the secondary circuit interrupted, and therefore with the resistance $r' = \infty$.

RESULTS OF EXPERIMENTS

Conducted November 11th, 12th, 13th, 14th, 15th and 16th, 1884.

Number of experiments.	Calorimeter in the secondary.		Calorimeter in the primary.		Resistances.	
	t_0'	t'	t_0	t	r_1	r'
1	10·60	16·95	16·18	22·80	4·80	4·70
2	8·90	15·00	14·98	21·55	5·18	5·09
3	15·50	21·00	19·90	26·00	6·10	6·10
4	14·96	20·32	24·70	30·70	6·73	6·80
5	11·28	17·29	16·05	22·90	7·50	7·73
6	9·10	13·80	13·60	19·50	9·17	10·02
7	8·90	13·90	13·70	19·70	9·53	10·02
8	17·65	22·00	21·62	27·42	10·72	12·12
9	16·45	20·20	19·92	25·70	12·55	15·43
10	9·05	13·00	12·75	19·00	14·70	17·70
11	14·20	17·98	16·68	22·26	15·14	17·73
12	18·35	22·02	21·70	27·90	15·35	19·80
13	16·64	19·92	19·48	25·42	16·17	21·50
14	—	—	14·50	20·20	22·36	∞

The results of all the measurements are comprised in the following table in which the letters have the following significations :—

t'_0 and t' represent the temperature of the calorimeter at the beginning and at the end of the calorimetric experiment on the secondary circuit (the first part of the experiment) ;

t_0 and t are the temperatures of the calorimeter read off at the beginning and the end of the calometric experiment on the primary circuit (second part of the experiment).

r_1 is the resistance of the conductor, b, r, F, 1, O, β, H, q (fig. 2) which in the second part of the experiment is substituted for the secondary generator;

r' is the total resistance of the secondary circuit, a, L, r', s, t, 1, O.

SEC. 9.—*Calculation of the Experiments.—Preliminary Observations.*

If we call p the constant of the calorimeter ; R the resistance of the spiral immersed in it ; and if we represent by i_m^2 and $i_{m'}^2$ the means of the squares of the intensity of the two currents, primary and secondary, during the experiments we have

$$\text{R}\, i_m^2 = p\,(t - t_o),\ \text{R}\, i_{m'}^2 = (p\, t' - t'_o),$$

hence

$$\left(\frac{i_m}{i_{m'}}\right)^2 = \frac{t - t_o}{t - t'_o}. \qquad (46)$$

This value is independent of p, and if, therefore, we take care to use in our calculations formula in which the absolute values of the mean intensity, i_m and $i_{m'}$, of the two primary and secondary currents do not figure, but to use in their stead merely their relation we can make all the determinations without encountering the difficulties inherent in all absolute calorimetric measurements. It is precisely to that end that the plan of the experiments has been studied, so as to make use of one and the same calorimeter, both for the measurements on the secondary and the primary circuit.

But it is necessary for the exactitude of the determinations that during the entire duration of each experiment the constant of the calorimeter, and its resistance should remain invariable. The former condition can be secured without difficulty ; the second cannot be fulfilled in a rigorous manner in consequence of the unequal heating to which the spiral is subjected in two portions of the experiment. If, as happens in general, the elevations of temperature, $t - t_o$ and $t' = t'_o$, obtained respectively in the calorimeter when it is inserted in the primary and secondary circuit are different, this signifies that in the same time—in a minute—the spiral gives off to the water of the calorimeter different quantities of heat, and this in turn demonstrates that the temperature of the spiral has different values in the two cases. To the difference of temperature of the spiral in the two parts of the experiment there corresponds a difference of resistance in virtue of which the value of $\left(\frac{i_m}{i_{m'}}\right)^2$ calculated according to (46) may be affected with an error. It is necessary before undertaking the calculations to render to ourselves an account of the magnitude of this error.

For this purpose let us call h the coefficient of external thermic conductivity of the wire of the calorimeter when immersed in water, F the surface of the wire in square metres, x the mean difference of temperature between the wire and the water during a calorimetric measurement of the primary circuit ; the number of calories transmitted from the wire to the water in an hour is h, F, x, and in a minute $\frac{h\,\text{F}\,x}{60}$. This number of calories raises the water from the temperature, t_o, to the temperature, t, and as on the average in my experiments the constant of the calorimeter was about 1·3, this number of calories will have the value 1·3 $(t - t_o)$.

To determine x we have then the equation

$$\frac{h\,\mathrm{F}\,x}{60} = 1{\cdot}3\,(t - t_0),$$

whence h may be understood with reference to the calories per hour and per square metre.

In my experiments $\mathrm{F} = 2{\cdot}40 \times 0{\cdot}001 = 0{\cdot}0024$. For calculating h with exactitude the data are wanting, but nevertheless we may take for h a value certainly less than the truth, by means of which we may calculate if not the exact value of x yet a value certainly greater than the truth, whence we may deduce a superior limit for the error which we commit in making use of the formula (46). Engineers know that a metal tube, *e.g.*, one of copper of small diameter, immersed in water and full of steam, may condense in an hour for each square metre of surface, and for each degree of difference of temperature between the water and the steam, 2·5 kilos. of steam if the water is at rest and near upon 10 kilos. if the water boils. Certainly the weight of vapour condensed will be greater still if the water instead of remaining in contact with the tube solely by means of hydrostatic movements were artificially renewed by means of an agitator. As it is moreover known that the coefficient of external conductivity increases with the decrease of the diameter of the tube, it will be certainly much greater than what corresponds to the condensation of 10 kilos. of vapour when in place of a tube we have merely a thin wire. We make, therefore, an error of deficiency in the value of h, and an error in excess in the calculation of x if we make the supposition that for our wire, h corresponds to the condensation of 10 kilos. of steam at 100° C.

We have, consequently, a limit of the error which it is requisite to appreciate, a limit much superior to the truth if we put

$$h = 10 \times 537 = 5370\,;$$

putting this value we have—

$$x = 6{\cdot}05\,(t - t_0).$$

The temperature of the wire of the calorimeter during the experiment will be on the average $x + \frac{t + t_0}{2}$, therefore as a certain error in excess :—

$$6{\cdot}05\,(t - t_0) + \frac{t + t_0}{2}\,,$$

since the resistance will be increased in respect to that corresponding to 0° in the ratio of 1 to

$$1 + 0{\cdot}00044\left[6{\cdot}05\,(t - t_0) + \frac{t + t_0}{2}\right].$$

Similarly during the experiment with the calorimeter in the secondary circuit the resistance will be that corresponding to 0° multiplied by

$$1 + 0{\cdot}00044\left[6{\cdot}05\,(t' - t'_0) + \frac{t' + t'_0}{2}\right]$$

Hence the value of $\left(\frac{i_m}{i_{m'}}\right)^2$ calculated by the formula (46) must be multiplied by

$$\frac{1 + 0{\cdot}00044\left[6{\cdot}05\,(t' - t'_0) + \frac{t' + t'_0}{2}\right]}{1 + 0{\cdot}00044\left[6{\cdot}05\,(t - t_0) + \frac{t + t_0}{2}\right]}$$

therefore approximately by

$$\varepsilon = 1 - 0{\cdot}00044\left[6{\cdot}05\,(t + t'_0 - t_0 - t') + \frac{t + t_0 - t' - t'_0}{2}\right]$$

On account of the uncertainty of the value of h, of which we have made use, this formula cannot serve effectively for making the correction in question, but as we are certain that the correction made with this formula will be in excess it is useful to give an idea of the limits of the errors which may spring from making use of the formula (46) without any correction.

For this purpose it will be sufficient to calculate with the formula found the error in case of the first and of the last of our experiments, since in all the others it will have an intermediate value. In the experiment No. 1 we have

$$t + t'_0 - t' - t_0 = 0^\circ{\cdot}27, \quad \frac{t + t_0 - t' - t'_0}{2} = 5^\circ{\cdot}71\,;$$

therefore

$$\varepsilon = 0{\cdot}997.$$

In the last experiment but one, No. 13, where the error in question is greatest, we have

$$t + t'_0 - t_0 - t' = 2^\circ{\cdot}66$$

and

$$\frac{t + t_0 - t' - t'_0}{2} = 4^\circ{\cdot}17,$$

whence $\varepsilon = 0{\cdot}991$.

It is therefore seen that the error made in calculating with $\left(\frac{i}{i'}\right)^2$ omitting the calculation for the heating of the wire, is within the limits of less than three per 1,000 in case of the small resistance, r', and less than nine per 1,000 in case of great resistances. And as the calculation which we have made is based upon a value of h probably much below the truth, we believe that in reality the error committed is notably within the limit calculated. Hence the results of the experiments used in the calculations, as we shall presently see, give no indication of a systematic error in the value $\frac{t - t_0}{t' - t_0}$, an error which increasing with r' and being always of the same sign, would be easy to recognise whenever it exceeded the magnitude of accidental errors of observation. If therefore it is observed that by the very nature of our experiments we cannot count with certainty upon the values of the results beyond the second decimal place, we are warranted in taking no account of the heating of the wire and in using the formula (46) without any correction.

These observations having been premised, we may make use of the results of the experiments recorded in the table given above.

(*To be continued.*)

DYNAMOS FOR PRIVATE USE.

ALLUDING in the *English Mechanic* to the erection of dynamos for private use, Mr. S. Bottone gives the following brief sketch of a dynamo which, he states, is doing excellent work.

While fully agreeing with a correspondent as to the superiority of compound shunt winding wherever a varying resistance is likely to occur in the circuit, he says :—"Yet I feel that to amateurs the greater efficiency and easier make of the series-wound dynamo will ever make it a favourite.

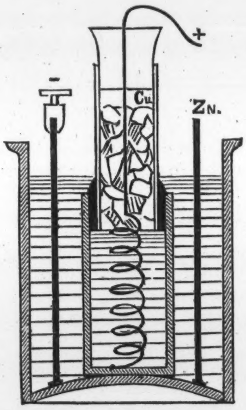
"The dynamo under consideration consists in a cog armature, 7 in. diameter from cog to cog ; thickness of ring, 1 in. ; outside diameter of ring (exclusive of cogs), 5¾ in. ; thickness of cogs, ½ in. ; depth of channel, ¾ in, ; number of cogs, 12 ; width of ring, 5 in. Wire on armature, No. 14, double cotton-covered in six layers, about 70 ft. to each channel, or 840 ft.—say, 18½ lb. The total resistance of this wire was 1·44 ohm, but the running resistance was only 0·359 ohm. The field-magnets consist in two bars of cast iron, carefully annealed, slightly oval in section, being 4 in. in the longest diameter by 3 in. in the shortest diameter, the length of the wound portions being exactly 1 ft. in each. These fit into two pole pieces of soft iron bored out to receive the armature. When fitted the pole piece is to form a cube 8 in. high, 10 in. wide by 5½ in. deep. A heavy cross bar of cast iron is bolted to the top ends of the F.M.'s.

"The field-magnets are wound with 96 coils of No. 12 wire, seven layers deep, the entire length being about 1,680 ft., or 63 lbs. The resistance in series was, as nearly as possible, 1·53 ohm, or about five times as great as that of the armature when running.

"Driven at a speed of 1,400 revolutions, this little dynamo lights easily and well 30 20-candle-power Swans. After a four hours' run, the machine was sensibly hot, but not too hot for the hand to bear. The E.M.F. at terminals was 55 volts; the indicated current was 30 ampères. The dynamo is driven by a 2½ horse-power engine, which is certainly not overtaxed."

A MODIFIED DANIELL CELL.

MR. CLEMENT H. WRAGGE gives a description of his new cell in the columns of the *English Mechanic*. He says:—"All who have used the Daniell cell know what trouble there is to keep the copper solution out of the zinc division, because it always has a tendency to creep over the porous partition or pot, and so into the zinc sulphate. This arrangement which I am about to describe completely stops this action, and so adds to the life of the cell. The solutions still mix, but only by diffusion through the porous pot; this cannot be stopped by any means which we know of. In making up this cell, I take a porous pot 1 inch shorter than the jar which forms the outside containing vessel, then take a piece of glass tube 4 in. or 5 in. long, and of a diameter slightly smaller than the inside of the porous pot, wind round one end of this a length of ¾ in. tape until it fits the pot tightly; soak this end in melted wax and place it in the porous pot; cover the joints with wax and allow it to set. This forms the cell to hold the copper solution. To form the negative pole, take a few yards of copper wire and wind it into a close spiral which just drops through the glass tube; leave a length of wire to form the outside connection. Bend a zinc plate to fit outer vessel, and the cell is complete. Charge in the usual way, and place a few crystals of sulphate of copper in the glass tube. It improves the cell to cork the glass tube, passing the wire through the centre of the cork. The solutions should be level with each other, and sufficiently high to cover the juncture of the glass tube with the porous pot. You will readily see that this form of cell makes it impossible for the copper sulphate to find its way into the zinc solution except by diffusion. This form of cell is well adapted for electric clockwork, and as I have seen many inquiring for a suitable battery for this purpose, I hope this will meet their wishes."



Driving Engines for Lighting the Inventions Exhibition.—Messrs. Goodfellow and Matthews are now erecting three large engines of 180-horse power for the Inventions Exhibition, where they are to be utilised for driving three dynamos, of powerful capabilities, manufactured by Messrs. Siemens Brothers, which will illuminate with the electric light the conservatories, grounds, and corridors.

REPORT ON THE B.T.K. SECONDARY BATTERIES.

To the Directors of the Consolidated Electric Company.

Gentlemen,—I have spent a long time in experimenting on the B.T.K. storage batteries. I am now in a position to state the efficiency and commercial output of the batteries tested, and to judge of the action of the master cell, and the general working of the cells.

For these experiments I used Sir William Thomson's graded galvanometers and two Ayrton and Perry's instruments. I calibrated the galvanometers for measuring current by frequent comparisons with a voltameter, and the galvanometers for measuring differences of potential by passing a known current through a known resistance.

It has been very usual to test the efficiency of an accumulator by a single charge and discharge. I do not consider that this is a trustworthy method. I took the mean of five charges and five discharges in succession, and the observations during this time numbered 960. I used 18 cells of the battery in series. The batteries were locked in a room of which I held the key. The experiments for efficiency lasted a fortnight. I invited your *employés* to supply me with the charging current which they preferred to use, and I discharged at the rate which they adopt in practise. I charged in every case until the master cell acted, and discharged until the E.M.F. had fallen more than would be convenient in practice.

On the first day the current was not strong enough, and the master cell did not act for 18 hours. The master cell generally acted well if a proper current was supplied, but it acts earlier or later as the current is stronger or weaker. If the current be properly regulated it acts well.

The experiments gave the following data for calculating the practical commercial efficiency of the battery:—

Total in 1st charge	...	10,905·32	
„ 1st discharge	...		3,779·25
„ 2nd charge	...	5,195·20	
„ 2nd discharge	...		3,804·27
„ 3rd charge	...	5,302·63	
„ 3rd discharge	...		2,835·48
„ 4th charge	...	3,997·51	
„ 4th discharge	...		1,829·63
„ 5th charge	...	2,632·39	
„ 5th discharge	...		4,635·64
Total charge	...	28,033·056	
Total discharge	...	... ...	16,884·274

True commercial efficiency 60·23 per cent.

The efficiency of batteries is sometimes given by using the E.M.F. of the batteries instead of the difference of potential between terminals. This is really of no value, but in this way my experiments give the nett efficiency = 67-69 per cent.

Several of the cells were not in perfect order, and lost their E.M.F. entirely, owing to this cause the efficiency given above is not so high as it would have been with better cells.

In order to measure the maximum output of these batteries, I charged them fully without the master cell, and measured the work given out. I thus got a total of 263-2 ampère hours. But in this time the E.M.F. had fallen very low indeed. The practical output was finished in seven hours, by which time the E.M.F. had fallen 18 per cent. and the output was 132·01 ampère hours.

The weight of the lead plates in a single cell was:—

7 Negative plates = 27 lbs. 3¼ ozs.
8 Positive do. = 30 „ 11 „

Total ... 57 14¼

(N.B.—I use the terms negative and positive as electricians use them.)

Thus we may say that the useful output is 2·3 ampère hours per lb. weight of plates. But this weight includes the supports and terminals of the plates. It must also be remarked that reports are often made of the output of storage batteries in which the weight of active material (the lead salts) is alone included, and the lead support of the plate is omitted; this is misleading.

A certain amount of bulging was noticed in some of the plates after a lengthy discharge. This would not occur with these plates when properly used.

In conclusion, my opinion is that these cells are good, and that their performance would have been better if they had been better treated before being placed in my hands. The inequalities in different cells would not then have appeared, and the injurious consequences would have been avoided.

After I had completed the experiments recorded in the above report, I was asked in view of my statement that the cells were not in perfect order, to test another battery of 18 cells by a single charge and discharge under favourable conditions.

The results are given below. In the foregoing experiments I had worked the cells under ordinary working conditions, charging them one day, and discharging them the next day at a fairly rapid rate. I now undertook to charge them until they gave off gas, and then immediately to commence the discharge at a slow rate, taking observations continuously at intervals of ten to thirty minutes.

This involved continuous observation during 26 hours. I have already stated that I do not consider the efficiency as determined by a single charge and discharge to be capable of the great exactitude which I had aimed at in my five charges and five discharges previously.

In order, however, to make the result as reliable as possible under the circumstances, I commenced work by charging for 45 minutes, and then discharged for an hour, and noted the E.M.F. I then charged for nine hours at the rate of 22 to 30 ampères, *i.e.*, from 1.40 p.m. to 10.10 p.m. on the 16th March, 1885.

I then discharged for about 14 hours at the rate of about 13 to 14 ampères. At the end of this time the E.M.F. had fallen down to what it was in my preliminary discharge. The discharge lasted from 11 p.m. March 16th, until 1.15 p.m. on March 17th. The charge put in was not the total charge which might have been given had the object been to measure the capacity instead of the efficiency of the accumulators.

The E.M.F. fell only 14 per cent. during the period of discharge, so that the batteries still retained a considerable charge; but in practical working the limits of charge and discharge which I used ought not to be exceeded.

The result arrived at was that the charge given to the accumulators was 242·18 ampère hours, and the discharge to reduce it to its primitive condition was 193·48 ampère hours, which gives the efficiency in ampère hours at 79·89 per cent. But this is not the true efficiency, because the E.M.F. and the resistance of the battery must be taken into account. Calculating the results in this way, the true and practical efficiency comes out 69·02 per cent.

I am able to form no reliable opinion on the probable life of these batteries, as it is impossible, without tests lasting over years, to obtain data upon which to form an opinion.

I think it right to point out that my method of testing (putting a number of cells in series) is far more severe, and is certain to give less satisfactory results, than if I tested a single cell. But it is the only method which gives a satisfactory idea of their action in practise, as it is usual to employ a number of cells in series.

I am, Gentlemen, yours faithfully,
GEORGE FORBES.

34, Great George Street, Westminster,
March 25th, 1885.

REPORTS ON ELECTRIC LIGHTING.

(*Continued from page* 376.)

b.—How can glow lamps and the light they emit be best distributed?

"I have said that a glow lamp of 50 candle-power lends itself best to street illumination. These lamps were fixed at various distances apart, and at various heights above the ground. They were placed by the sides of the streets and scattered in various ways, but the best effect was produced when they were suspended over the centre of the roadway, 25 feet from the ground. If such lamps were placed in dioptric globes 50 feet apart, the light would be evenly and uniformly distributed. A very great number of reflectors of different patterns were tried, and their effect measured. Diagram No. 3 illustrates some measurements taken. The best effects, as judged by the eye, were obtained by bright nickel-plated iron discs of 18 inches diameter.

"In dealing with the distribution of light from an economical point of view, I must deal partially with estimate and calculation.

"A horse-power in London can be supplied at one penny per hour for a day of six hours. Taking the net efficiency of the machinery and conductors at 67 per cent. or 500 watts to the horse-power, the cost of a watt hour is ·002d.; although we may hope eventually to obtain in glow lamps one candle-power for each watt expended, we cannot estimate for less than 2·5 watts per candle at present. Hence one candle-power by incandescence costs ·005d. per hour, and 50-candle lamps cost ·25d. per hour, therefore three 50 candle-power lamps, or 150 feet of street, cost 0·75d. per hour. On the other hand, one candle per watt is easily obtained by arc light, though the average useful light from the Brush lamp is by measurement not more than one candle per 1·9 watts.

"Let us take it at 1·49 watts per candle, or one actual horse-power per lamp, then each 150 feet of street costs one penny per hour, while when illuminated by glow lamps, it costs only 0·75d. for the same time.

c.—The Cost of Working.

"The experiments at Wimbledon were carried on from March 21st to June 21st, 1884. The nature of the experiments involved considerable variation and irregularity in the working, but I was able to obtain eight weeks' continued working of 76 lamps of 20 candle-power, and to reduce the cost of working to an average of six hours per night, and therefore to so much per lamp per hour. Table B gives the result:—

TABLE B.—EXPENSES OF 76 LIGHTS FOR EIGHT WEEKS, *Wimbledon*, 1884.

		£	s.	d.	Per night of six hours.	£	s.	d.
Coal	7 horse-power @ 4 lbs. per horse-power per hour @ 18s. per ton	3	15	6	1½ cwt.... ...	0	1	4
Wood	2d. per night...	0	10	6	... ...	0	0	2
Oil	3½ gallons @ 4s. 6d....	0	16	6	Oil and waste, say	0	0	4½
Waste	8 lbs.	0	4	0				
Lamps	*76 lamps at 1,000 hours' life @ 5s. per lamp	6	8	0	Lamps, say ...	0	2	3½
Do.	Repairs	0	6	0	Repairs, &c., say	0	0	1¾
Brushes	Brushes @ three months per set	0	2	0				
Wages	Lampman	9	4	0	Wages... ...	0	8	8
	Driver...	11	12	0				
Interest and depreciation	Interest and depreciation on £500 at 10 per cent.	7	6	0	... ...	0	2	6
	Total	£40	4	6	... ...	£0	15	5¾

* This life is guaranteed by the makers.

This is equal to 0·408d. per lamp per hour.

Now, since the same staff could have attended to 400 similar lamps, Table C shows what the cost would have been had that number of lamps been used:—

EXPENSES *per Night* OF 76 LIGHTS FOR 8 WEEKS.

TABLE C.

		£	s.	d.
Coal	40 horse-power, at 4 lbs. for 6 hours, = 8½ cwt....	0	7	8
Wood	... ...	0	0	2
Oil	2 pints (and waste)	0	1	3
Repairs, &c. ...	... .	0	0	4
Lamps	Renewals, at 1,000 hours' life, at 5s.	0	12	0
Wages	... ...	0	8	8
Interest and depreciation ...	at 10 per cent. on £1,600	0	8	9
	Total	£1	18	10

= nearly 0·2d. per lamp per hour.

The actual cost of 76 lamps was less than ½d. per lamp per hour; the estimated cost of 400 lamps is nearly one-fifth of a penny per hour, the same price as an ordinary gas burner burning five cubic feet per hour, when gas is 4s. 2d. per thousand cubic feet. This, however, is independent of rent. Rent would probably bring it up to one farthing per lamp per hour. Let us take it at one farthing per lamp of 20 candles per hour. It follows that a 20-candle-power glow lamp can be maintained for the same price as a nominal 14-candle-power gas burner, such as those used in the streets of the City. But in this calculation no allowance has been made for capital, supervision, accident, insurance, &c., items very difficult to allow for, but all of which are contingencies which must be taken into consideration. I prefer to take as my unit 10-candle-power, not only because I experimented with such lamps, but because it is the mean average of the existing street gas lamps, and a very convenient number for glow lamps.

"Taking all facts into consideration, I think I am fully justified in estimating the total cost of producing 10 candle-power by glow lamps, for six hours per night, at not less than ¼d. per unit per hour. It is probable that this would be too high if we employed 50-candle lamps, for the charge on renewal and depreciation would be diminished, owing to there being fewer lamps to renew; but I would rather have my estimate too high than err on the wrong side.

"The result is, that when we compare lighting our streets by gas and by electricity, the cost of each at the present price charged for gas is about the same, but the conveniences and advantages of the electric mode are so manifestly superior to the gas, that it is difficult to justify a continuance of the present method. It will perhaps be instructive to record the accidents and failures that occurred during this three months' trial:—

"1. March 21st.—Bearing of dynamo got very hot. No stoppage.

"2. March 22nd.—Lacing of belt gave way. Three minutes' stoppage.

"3. April 1st.—Parallel or group gave out, owing to lamp breaking or being broken. Circuit stopped for 39 minutes. No automatic compensation in use at this time.

"4. April 7.—Another parallel gave way during experiment, owing to imperfect adjustment.

"5. April 29th.—Another parallel gave way, owing to a change of dynamo.

"[N.B.—After this, compensating secondary cells were inserted in each group, and this liability to failure cured.]

"6. May 12th.—Three lamps went out, probably from stone throwing, but compensating cells prevented any breakdown.

"7. June 10th.—Coil gave way in dynamo—all lights out.

"These were all the accidents that took place, and were all due to preventable causes. The last failure would not have interfered with the lighting had there been, as there ought to have been, a spare dynamo, for the defect was observed long before it interfered with the lighting. The arrangements were made, and the experiments conducted by Mr. Albert H. Howard."

6.—DOMESTIC LIGHTING.

Here Mr. Preece describes the installation with which he has fitted his own house, the details of which have already been published in the ELECTRICAL REVIEW for October 25th, 1884. In relation to this matter he arrives at the following conclusions:—

"1. That electric lighting, when obtained by an isolated plant such as mine, is a luxury that must be paid for as a luxury. I could not with my present experience fit up my house for less than £300, or, say £7 10s. per lamp; but of course this will vary with the artistic taste and character of workmanship displayed in the fittings.

"2. I ought not to consume more gas for power than I have hitherto done for light. Indeed, I think I shall consume less. I can say that my house is still lighted by gas, but I now consume my gas in my garden, and not in the house, extracting from it that which I want—*light*—and discharging into the external air that which I do not want—*poison*. Hence I have filtered my light, and purified the air I breathe.

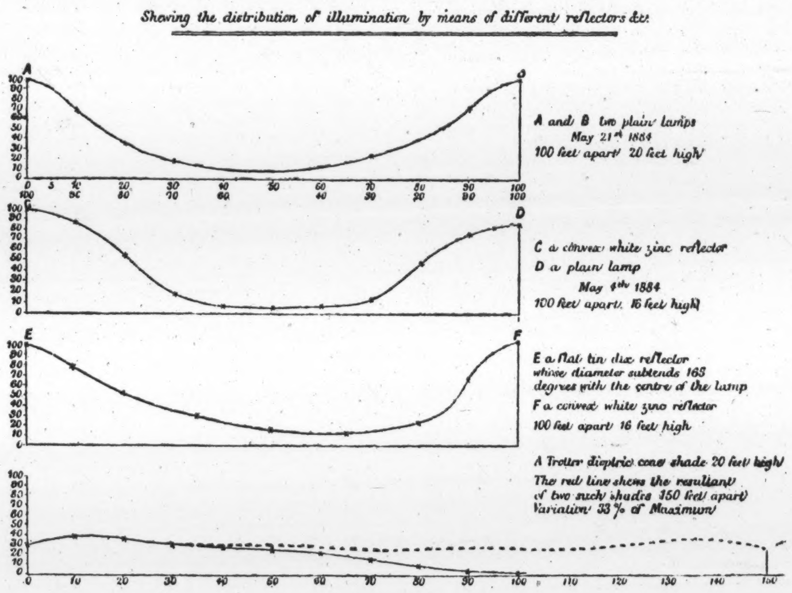


DIAGRAM 3.

"3. The steadiness, charm, and comfort of the light, the durability of my decorations, the absence of heat and of all destructive gases, the non-vitiation of the air of my rooms, and the longer life one gains in consequence, make up a splendid dividend on the capital I have invested.

"4. It is idle to deny that there are many difficulties that yet exist to be surmounted, and that can be overcome only by technical skill and experience; but this experience is being rapidly gained, and this technical skill is coming within the reach of all.

"5. One important item of economy in electric lighting is this, that one need expend energy in light only when and where it is wanted. When gas is used a servant goes round and ignites the gas jets, and they are left for hours to waste away unnecessarily and expensively, whereas with electricity a switch near the door or on the lamp enables one to produce a flood of light only during the time it is wanted, and without a match or taper. Hence if electricity costs twice or thrice that of gas it need be expended only one-half or one-third the time.

"6. By the use of such a low pressure as 31 volts, no shocks are possible, nor is there any fear of fire or damage to insulation. Matches and candles are rendered unnecessary, and therefore the security from fire is immensely enhanced.

"7. All the trouble and difficulties that I have encountered will be entirely eliminated when electricity can be supplied at our doors as gas is now. They would also be very much reduced if the installation were large enough to justify the employment of a technical hand to look after it. But before electric lighting can be general, the economical distribution of electricity from central points is imperative.

7.—CENTRAL STATION LIGHTING.

"If electricity could be supplied at our doors in the way prescribed by the Act of 1882, so that we should have a constant service at a constant pressure, all the difficulties that I have experienced in producing my currents in my own house would disappear. Electric lighting would become general—every one would have it if the price were reasonable. But the difficulties and cost involved in distributing the electricity at present are so great that there is not a single central station at work in London. The mechanical and electrical difficulties are being surmounted, but the financial difficulties remain. The Act of 1882 renders it impossible for any company to be formed to carry out the provisions of the Act. Its restrictions are so rigid that it has entirely checked electrical lighting by private enterprise. Of the 73 Provisional Orders obtained in 1883, not one has been persevered with. The only installation that has been carried out under the Act is that at Colchester, and that is done by a company which has a small unexpended capital. Electrical lighting on a large scale means a very large capital expenditure. This capital can now be raised only by the corporations concerned and on the security of the rates. The Act is of no use for the purpose for which it was passed, and it is questionable whether a local authority like the Commissioners of Sewers of the City of London need regard the Act at all should it determine on establishing an electric lighting system. This, however, is a legal question on which I am not competent to express an opinion.

"Assuming that it were decided to light up a portion of the City as a tentative measure, the all-important question of the distribution of electricity is a very knotty point indeed to decide. I must confess that I am not convinced as to which is the best system, and without further experience and careful examination I should hesitate to recommend either of the systems I have described as being the best. Indeed, the room for invention in this direction is so extensive, that it may happen that in a short time some plan more perfect and still more economical may be introduced.

"In a report made to the Streets Committee on the 2nd November, 1882, I made the following remark: 'The whole question of the distribution of electricity for lighting purposes is in a very tentative state; sufficient experience has not yet been gained to determine exactly what is required under all circumstances, or even what those circumstances will be, and I think that those corporations who have taken upon themselves to supply electricity have undertaken a responsibility that they have not sufficiently contemplated, and which, with the present state of our knowledge, is extremely difficult to discharge.'

"I venture to remind the Committee of the truth of this, and to assert that at the present moment it is still to a great extent the state of the case—electric lighting is unquestionably a great success, but the best means of developing it economically and practically, on an extended scale, have yet to be decided. To attempt to light up a large area with our present experience, and in face of an objectionable Act of Parliament would be unjustifiable, but to take a small area as a tentative measure, would be a wise and proper course to adopt, and it is that which I very strongly urge the Committee to agree to.

8.—STREET LIGHTING.

"The lamp which, in my judgment, best lends itself to street lighting is the glow lamp, and of the glow lamps I prefer the 50-candle lamp for the main thoroughfares. It was very successfully employed on the Holborn Viaduct, where there were 16 16-candle power (nominal) lamps and 76 32-candle power (nominal) lamps, No more perfect specimen of street lighting was ever seen than the experimental illumination of the High Street, Wimbledon. The lamps were fixed over the centre of the road. They had not the captivating brilliancy of the arc lamp, but their light was evenly distributed and there was no waste. There would, I fear, be great difficulties in suspending lamps over the centre of the roadway in the City, owing to the requirements of the Fire Brigade, whose escapes require a headway of 35 feet, but an admirable effect would still be obtained by fixing these lamps on posts on the curbstone, as at present, and 50 feet apart. I should much like the Streets Committee to select a main thoroughfare and allow the experiment to be tried. Whatever difficulties there may be in introducing domestic electric lighting, cease altogether when we regard street lighting. There is no difficulty in distributing the current; the whole of the streets of the City could be illuminated from one centre; the lights could be turned on and off in one second. If the power required to produce the currents were obtained from gas engines, then on the approach of fogs the streets could be instantaneously lighted without sending round any lamplighter."

W. H. PREECE.

THE INVENTIONS EXHIBITION.

IN our issue of 21st March we gave a general programme of the electric lighting at this year's exhibition at South Kensington. In view of the opening by the Prince of Wales on Monday next (4th May), great progress has been made with the various necessary preparations, and a good idea can now be formed of what will be the effect of the alterations and additions which have been carried out since last year. The first thing that will arrest the attention of the visitor who reaches the building by the main entrance will be the altered appearance from that spot of what was called last year the South Gallery. In addition to the long building, then so called but now named the Middle Court, there are two new galleries, of about equal span but not running the same length, on each side of it, named respectively the North Court and the South Court. The Middle Court, as before, will be lit by Messrs. Siemens, by means of 20 C.P. Swan lamps to the total number of 1,040. These are arranged in a series of arches to the number of 80, each arch of 13 lamps being at a distance of about 10 feet from each other. In the new court to the left, the South Court, the Edison and Swan United Electric Light Company will have 1,000 glow lamps arranged in five lines along the roof from end to end, a group of four lamps in a rectangular holder, alternating throughout with a single lamp in a coloured drop, the effect of which is relieving to the eye without being obtrusive. It is here that visitors coming from the station by the new subway will enter the exhibition. The subway is continuously lit with glow lamps, also by the Swan and Edison Company. A Mather and Platt high-speed engine of 190 H.P. drives the dynamos for these lamps. In the new court to the right, the North Court, the lamps are arranged in a similar way to those in the Middle Court, the only difference being that each arch of 13 lamps is slightly broken by two being coupled in a single holder midway each side. These are the Victoria lamps of the Anglo-American Brush Company, and are fed by three dynamos driven by a Parson's engine of 150 H.P.

Among the new systems this year is that of the Thomson-Houston Electric Company, now represented in this country by Messrs. Laing, Wharton, and Down, of Holborn Viaduct. The exhibit consists of 45 arcs of 1,000 C.P., and 18 of 600 C.P., and additional interest will be taken in it from the fact that the dynamos will be driven by the first Armington and Sims engine made in this country. An exhaustive description of the Thomson-Houston system was given in the ELECTRICAL REVIEW of November 15th and 22nd last, when it was stated that at that time the number of the Thomson arc lamps in use in the United States exceeded 10,000, whilst in Canada it was the only system which had met with much extension. The 16 lamps of 800 C.P. in the electric light shed this year will be the first public trial of the arc lamp patented by Mr. G. D. F. Andrews, of Glasgow. Messrs. Gaulard and Gibbs will have a demonstration of their system of distribution, having undertaken to light the Eastern Arcade and Western Avenue, where they will use the small Varley arc lamps of 200 C.P. Messrs. Cordner and Allen also have 24 arc lamps in operation for the first time. A striking improvement this year is the substitution for the tedious lighting of the thousands of Vauxhall lamps, which were in use last year, of an instantaneous lighting of the garden, terraces and outlines of buildings, by about 20,000 electric lamps. This, in the words of the official programme, will be "an interesting and novel spectacle never before witnessed in this or any other country, and no visitor should fail to see it." These tiny incandescent lamps are fed by three Siemens B^3 machines, actuated by three "Triplex" Tandem engines supplied by Messrs. Goodfellow and Matthews, of Hyde, near Manchester, each of which is calculated to indicate upwards of 200 H.P., with a boiler pressure of 120 lbs. per square inch, and a speed of 320 revolutions per minute. The cylinders are 9 in. and 18 in. diameter, 10½ in. stroke; the mean piston speed is, therefore, 560 feet per minute. These are located in a shed erected for the purpose at the back of the Conservatory. Altogether the electric lighting this year will show that steady progress is being made, and will not only be more effective as compared with former years, but will possess features of considerable interest both to those engaged in electrical pursuits and to the general visitor.

In Class XIII.—Electricity—arranged in the Eastern Arcade—will be found a number of exhibits by firms in various branches of electrical business, including storage batteries by the Electrical Power Storage Company; electric light fittings, switches, &c., by the Anglo-American Brush Company; electrical apparatus by H. and E. J. Dale; wires and cables for telegraph, telephone, and electric light work, including patent ozokerited I.R. insulation and patent troughing for underground conductors, by Henley's Telegraph Works Company; patent insulated wires for all purposes by Callender's Bitumen, Telegraph, and Waterproof Company; an arrangement of concrete and iron, and the patent box street circle for conveying electric wires through streets, and patent belt cables, by Sellars and Company, Birkenhead; large electric bells for works and special purposes by Messrs. Harrison, Cox-Walker, and Company, Darlington; a method of fully utilising the light of incandescent lamps by silvering a part of the globe, the combined patent of Messrs. J. G. Lorrain and Sidney Waters; a working model of the Telpherage system of Professor Fleeming Jenkin; vulcanite fibre in the form of sheets, tubing insulators, and bell pushes, by Messrs. Mosses and Mitchell.

There is a special stand of Swan lamps exhibited by the inventor, Joseph Wilson Swan, of Bromley, Kent, illustrating all the various types of these lamps, their special features, and various practical applications. Numerous specimens of the well known ordinary Swan lamp are shown in different styles of ornamental fittings, the cut glass electroliers and pendants being lent by Messrs. Osler and the brass fittings by Messrs. Faraday and Messrs. Winfield. A novelty shown here consists of an orange tree in which the oranges are illuminated internally by Swan lamps. A surgical lamp for illuminating the internal cavities of the living body during operations is here exhibited, together with specimens of miners', divers', microscopical, dental, and fairy lamps. Among Mr. Swan's recent inventions here shown are an electric meter, consisting of the combination of a clock and galvanometer, which indicates on dials, similar to those of a gas meter, the amount of electricity used by each consumer; and specimens of a new filament for making the carbons of incandescent lamps, which is produced from a liquid by pressure through a die. This invention is patented, and is the property of the Edison and Swan Company. Mr. Swan also shows improved safety catches, new designs of switches, subways for electric light mains, and improvements in storage batteries. There is also exhibited at this stand a testing apparatus, illustrating the effect of different electric potentials on the light given by the lamps. The three arches in the middle of the East Arcade, on each side of the Swan stand, are lighted by forty-four 100-candle power Swan lamps, fitted, two in each, to handsome crystal lanterns lent by Messrs. Osler. The whole of the lamps were manufactured and supplied for Mr. Swan by the Edison and Swan Company.

The complete catalogue of the Exhibition is announced to be ready by Monday, but in the meantime there has been issued, under the authority of the Executive Council, a very useful "Railway Guide and Route Book," which should be at once purchased by everyone intending to visit the Exhibition. It gives useful and interesting notes for visitors as to the general arrangements in the buildings; particulars of the arrangements made with the railway companies for the issue of joint tickets, and the best means of travelling to and from the Exhibition; a map depicting the general railway systems in London and about 25 miles round; cab fares and distances; details of omnibus and tramcar services; and a very comprehensive ABC railway guide, showing, as to each station within the 25 mile radius, the shortest route, fares (including admission), the average intervals between trains during the afternoon and evening, the time occupied in the journey, and the time the last two trains leave for the return at night. The whole forms a book of 120 pages, and is sold at one penny.

LEGAL.

Irish v. Northern District Telephone Company.—(Sittings at Nisi Prius, before Mr. Justice Grove, without a jury.—April 24th.)—This was an action by an electrical engineer to recover as damages a certain sum for "royalties" on switchboard apparatus for telephones supplied to the defendant company at Sunderland. The plaintiff claimed £107 5s. 10d.—£38 10s. 10d. for the manufacture and use of certain machines, and the residue as royalties on those supplied by him to the defendants. The plaintiff took out his patent on March 3rd, 1882, with a provisional specification; on March 16th, 1882, he made an agreement with the defendants for the supply and use of his boards. On the 27th of March, 1883, he assigned his patent right to the defendants, and issued his writ in this action on July 16th following. The defendants denied that they had made or used any machines except the nine supplied to them by the plaintiff, and which they had paid for. In the result the learned Judge, characterising the agreement and assignment as misleading, ungrammatical, and puzzling, gave the plaintiff a verdict and judgment for £56 5s., or 2s. 6d. royalty on nine circles of 50 wires each for subscribers, with costs.

THE TELEPHONE AND TELEGRAPH COMMITTEE.

This Select Committee concluded their labour so far as the taking of evidence is concerned at their last sitting, and it now only remains for them to decide upon their report. What that will be cannot safely be predicted, but we shall not be surprised if the main report is accompanied by more than one independent report from minority members. Since our last *résume* much valuable and varied evidence has been received, the first witness now to be noticed being

Mr. Pilditch, Surveyor to the Wandsworth Local Board. He stated at the outset that last year, when a telephone company sought to erect an overhead wire, his board took the question before Mr. Justice Stephen, and obtained judgment against the company. But that decision was set aside on appeal, and, in consequence, the company had been free to act as they pleased. Under these circumstances, the board felt that something ought to be done to restrict the growth of overhead wires, and that to the local authorities should be left the decision as to whether a wire should be allowed (by licence), and whether it should be under or over ground. They were of opinion that all wires ought to be underground, and certainly no wires should be placed over houses without the supervision of the local authorities. Already several accidents had occurred, and one, at Balham Hill, in October, 1881, had proved fatal. During a storm a tree had fallen, and carried with it a Post Office wire and post, and the post had killed a man. A wire at Battersea had also fallen, and with such weight and force as to have tightly wound itself several times round a lamp-post, and then it stretched across the road in such a way that if it had fallen in the night passers by would have been exposed to serious danger. The witness mentioned some other cases, and he also stated that both the Post Office and the telephone companies frequently made attachments to houses during the night without the permission or knowledge of the occupiers, and so no one could tell to whom they belonged. In fact, they did pretty much as they pleased in fixing wires.

In reply to Mr. Gray, Mr. Pilditch expressed the belief that the wire at Battersea could not have been twisted as it was by any person, and upon this Mr. Gray suggested to the committee that on a point of such importance they ought to call some technical evidence. At the subsequent sitting Mr. Preece was examined specially upon the point.

Mr. Allison, City Surveyor of Manchester, gave some results of his experience of wires in that city, where there had been a great increase in the number of wires during the last three or four years. He urged generally that wires should be placed under ground, and said there had been several accidents, some fatal. Mentioning that the Corporation of Manchester spent about £50,000 a year in widening and improving streets, he protested against wires being allowed to be run across these streets in an unsightly manner. Wires fixed diagonally across streets were very objectionable, and at least they ought to be fixed at right angles. He believed the average duration of a wire in his district would be from four to five years. Where overhead wires were permitted provision should be made for their removal, if necessary, as interfering with property, or as being otherwise objectionable, and there ought also to be a minimum height of 40 feet fixed to enable fire escapes to pass under. He would allow no right to be acquired by the owner of wires through user or lapse of time, and he would require every wire to be registered, in order to fix the ownership and liability. The corporation had obtained an Act enabling them to frame bye-laws, but they had not put it in force, because they wished first to gain experience. The Act was therefore practically a dead letter, and they had not carried out the inspections they were empowered to make. He would place the Post Office under the same restrictions as the telephone companies, for although most of their wires were under ground, they might change their system. Although, through a desire not to check the development of the telephone the corporation had not yet put their Act in force, yet, owing to the increase in these wires, they must now make bye-laws, and these they would be willing to submit for the approval of the Board of Trade, with an appeal to that body by telephone companies. In some streets in Manchester there were as many as 2,000 or 3,000 wires, all the telephone wires, and the greater number of the Post Office wires, being overhead. It would, he believed, be practicable to construct subways in Manchester, at least for the main trunk lines, and in his view wires might be laid underground almost as cheaply as overhead if several were laid down together.

Mr. Dunscombe, City Engineer and Borough Surveyor of Liverpool, stated that the Corporation of Liverpool had also obtained an Act for framing bye-laws to regulate telegraph and telephone wires. They had framed such bye-laws, and they considered their powers sufficient to protect the public; and, on the whole, they thought there was practically no greater danger from overhead wires than from underground wires, if the former were properly put up. They never allowed posts to be erected on the public highways, and as a rule the wires were carried over the housetops. The telephone had become a business necessity, and in the opinion of his corporation every reasonable facility should be afforded for its development consistently with public safety and convenience. Any large expenditure in carrying lines in iron pipes underground would have to be defrayed by the general public using the lines, and that in many cases would so increase the charges as to render them prohibitory. Mr. Dunscombe further insisted that the corporation must be the authority to make bye-laws, subject to the approval of the Board of Trade, and with a right to the corporation to be heard. Subways for all kinds of pipes would cost from £40,000 to £50,000 a mile, and the cost would have to be recouped from rentals charged to all who used them. A subway for all purposes would probably have to be 10 feet across and 12 feet or 14 feet in height.

Mr. Lawes, C.E., President of the Association of Municipal Engineers, and City Engineer and Town Surveyor of Newcastle-on-Tyne, stated that his corporation had, with one or two exceptions, uniformly insisted upon telephone and telegraph wires being placed under ground. Within the business area of the town they had not relaxed that rule, except in one case, but in the thinly populated districts they had allowed wires to be hung from posts. In the exception mentioned, leave was given to the Northern District Telephone Company to carry their wires over the Close, which ran parallel with the river, and in which the buildings were intercepted by "chairs" (or passages). In that case there would have been hardship in insisting upon underground wires, and therefore the exception had been allowed. The corporation had resolved to have telephone and telegraph wires under ground, through observing the great growth of these wires in other large towns, and through fear that these wires would become a source of danger, as they had become in Manchester, Liverpool, and other cities. There were some overhead wires in use in Newcastle, but they were so few that they would hardly attract any notice. They had had no accidents; and although the use of the telephone was rapidly spreading, they were still able to meet that increase by the underground method. They had not interfered with existing wires except in one case, in which they asked the Post Office to bury certain wires until they reached the outskirts of the town. This the Post Office had done, and he was not aware that any inconvenience had arisen. He was not aware of any accident from overhead wires, but they were a potential source of danger, and ought to be put below ground. The corporation did not at present inspect these wires, but if a wire became disused, and likely to fall, they would be able to deal with it as a dangerous structure. He had communicated by telephone up to 10 miles (that was to Sunderland) under the existing system, and he had found the communication distinct and perfectly satisfactory. In fact, the working of this underground system was very satisfactory. He had heard that some of the witnesses had said there were scientific difficulties likely to make an underground system impracticable, but in Newcastle the system was complete and perfectly practicable. As to the question of prohibitory cost, there were 500 members of the telephone exchange in Newcastle, and he had no reason to suppose that the telephone would have been more widely extended if the wires had been carried overhead. Indeed, he did not suppose the charges would be reduced if the wires were taken overhead, and he did not believe the action of the corporation had impeded the development of the telephone. Certainly that would be the last thing they would wish to do. The corporation did not wish for a power of absolute veto, but they did desire power to make bye-laws, subject to the sanction of the Board of Trade, and to control the wires. The people were perfectly satisfied with the present underground system, and the corporation were anxious to retain it in force. The subscription for a single wire in Newcastle was £14 10s., but he believed that if several wires were placed together they could be laid under ground more cheaply than over head.

Mr. Horn, of the Westminster Vestry, gave evidence on behalf of that and several other Metropolitan Vestries in favour of greater powers of control for local authorities, with an appeal in regard to bye-laws to the Metropolitan Board of Works. He declared that these overhead wires had now so multiplied that they were an intolerable nuisance, and in future all wires ought to be placed underground.

At the next and last meeting of the committee,

Sir Joseph Bazalgette, Engineer to the Metropolitan Board of Works, was the first witness. He explained that prior to 20 years ago there were few overhead and no underground wires in the Metropolis, but now there were many hundreds of miles of both kinds. There had been some accidents, but they were not serious on the whole. But as the chance of danger increased as the wires were multiplied and as wires became worn, some greater supervision had become necessary. For that purpose he thought the Metropolitan Board of Works was the proper authority, and under the Building Act, which mapped out London into 72 survey districts, they had excellent machinery for carrying out work of that kind. The Board of Works might make the bye-laws for the Metropolis, and he did not think there would be any advantage in giving an appeal or veto to a Government Department. At the same time private owners would have sufficient protection in the Board of Works on which they were represented, and then he would give the Board final power, and not allow owners to have a veto, because if they had a veto the public safety might be endangered. But while the Board had a compulsory power, owners should be entitled to pecuniary compensation; and it would be well to require a nominal payment to an owner to prevent a right accruing from user. The Board of Works should make the bye-laws, but the local authorities should be left to see them carried out, and local authorities should also have a right to be heard against any bye-laws laid down. As to the whole of the United Kingdom, he thought there should be some limit to the principle of central control, and he believed the question of damage through entering premises could be settled by the local authorities.

Mr. Jansen, solicitor, next gave evidence on behalf of a number of solicitors and agents representing the Duke of Bedford, the Marquis of Salisbury, Earl Cadogan, several City companies, Guy's, St. Thomas, and Christ's Hospitals, and a number of other large property owners in London. He explained that as manager of the Pollen estate his attention had been drawn to the question of wires erected over houses and from posts without permission, and he invited a number of other managers and solicitors to meet and consider the subject. They instituted an inquiry, and finding that so many wires had been put up without consent, they served notices on the United Telephone Company to remove the wires. This the company met by giving them an acknowledgment that all of their wires so erected existed only on sufferance. A similar acknowledgment had been given to the Duke of Westminster. At their meeting the representatives passed resolutions in favour of greater control over and a complete registration of these wires, the latter in order to ascertain the ownership of wires and to prevent wires being put up surreptitiously. Since then they had also come to the conclusion that the sanction of local authorities should be necessary to the fixing of fresh wires, and that wires should be under the control and supervision of the local authorities with an appeal to the Board of Trade, Local Government Board, or Metropolitan Board of Works. They very much preferred that wires should be laid underground, partly because of public safety and partly because of the unsightliness of overhead wires, and the consequent injury to property. At all events they thought there should be no addition to existing overhead wires. He had not heard of any accidents to persons except through statements in the newspapers, but as an instance of injury to property he mentioned a case at Glasgow in which an electric light wire attached to a chimney stack had pulled the stack over, and brought down eleven tons of material on to the adjoining building. He and those he represented held that the assent of both landlord and occupier ought to be obtained for merely running a wire over a house, and *a fortiori* for making attachments. The telephone was no doubt a great convenience, but he could not regard it as a necessity, and the existence of the telegraphs made the necessity still less.

In reply to Mr. Gray, the witness said he did not know that while the electric light wire weighed nearly 150 lbs. to the 100 yards, the telephone wire weighed only 3¼ lbs. to the 100 yards; but certainly he should not expect a telephone wire (such as a specimen shown him by Mr. Gray) to pull over a chimney stack. He and other agents had not offered any opposition to wires for any of their tenants, except to protect the vested rights of owners; they had, on the contrary, given permission in many cases. He had not heard that the Duke of Bedford had absolutely shut out all telephones from Covent Garden, because his tolls might be reduced by increased facilities of communication, but even in that case, or in the case of the Temple, he would not deprive the landlord of his right of option.

Mr. Preece, Chief Electrician to the Post Office, was called to give the results of his examination of telephones in America. He said he visited the States in 1877, and brought over the first telephonic instrument that was ever practically used here. At that time there was only one telephone exchange open in America, and the wires were invariably overground; but up to last year there had been an enormous development of the telephone as compared with its progress here. In New York and its neighbourhood alone there were more telephone subscribers than there were in the whole of this country; and in Chicago, Baltimore, Boston and Philadelphia, and other towns, there were from 1,000 to 2,000 subscribers. Without exception all the wires were carried over head, and across the Broadway, New York, there were six distinct lines of poles carrying overhead wires. These poles were fixed in the kerbs, and the result was that the streets were ruined and disfigured in appearance. There had been great outcry there against the wires, but only on the ground of disfigurement and obstruction, and not of public danger. Many of the local Legislatures had passed Acts for compelling both telegraph and telephone wires to be put under ground, but in no case had this been carried out, for the companies in America did not like to be driven, and their reply was, that if they were shown a practical way of working an underground system they would adopt it, unless it was too expensive. He had heard of three or four cases of fire having been caused through electric light currents getting in contact with telegraph and telephone wires, and so diverting the strong currents into an office and setting fire to the place. In consequence of these fires the electric light companies had adopted a special electro-magnetic cut-out, which came into operation immediately an electric light current entered a telephone or telegraph wire. Mr. Preece attributed the greater growth of the telephone in America mainly to a higher appreciation of it by the people than was shown here, and stated that while in one system the cost was equivalent to £42 a year, the general cost was equal to £30 or £35 a year, adding, however, that the telephone and other wires in America were heavily taxed as a source of revenue. There was no scientific difficulty in having an underground system, but there was a practical difficulty. For telegraph purposes an underground system tended to diminish the speed of working, and of carrying capacity, and, as to telephones, the same influence removed the clearness of articulation in speech, and at a certain distance speech became practically impossible along an underground wire.

Being questioned by Mr. Gray with special reference to the Battersea wire case, mentioned by Mr. Pilditch at the previous sitting, Mr. Preece said he had gone very thoroughly into the circumstances and he had come to the conclusion that the only possible means by which that wire could have become so twisted round the lamp-post was by its having been rolled round the post by passers-by.

Mr. Patey, one of the secretaries to the Post Office, being briefly examined, said the Post Office still adhered to the opinions previously expressed as to alterations in the present law, and added that it was very doubtful whether any system of inspection would be useful because it would tend to remove from the Post Office or telephone officials their sense of responsibility in the care of the wires, and they were most competent through their constant experience to properly maintain the wires in safe condition.

Sir George Campbell, M.P., tendered evidence as a "typical householder," and described the grievance he felt respecting the present state of things. He had, he stated, determined from the first that he would give no authority for placing wires on or over his house in Gloucester Road, feeling that that ought not to be done without the consent and control of the local authorities. Wires had, nevertheless, been carried over and attached to his house, by whom and when he could not ascertain. The first wire came he knew not whence, and went he could not tell where; passing from one invisible distance to another invisible distance. During the recent storms the first wire had come loose, and although he gave strict orders to his servants not to allow any one to go on the roof to repair the wire without explaining who he was, the wire had been mysteriously put up again, and another wire also attached to his side of a party chimney stack. He had no wish to retard the telephone, but he was strongly of opinion that wires ought not to be put up, even with the consent of a householder, except under the assent and control of the local authorities. Every wire should be registered, and a plan of an intended wire furnished to the local authority, who would then decide whether to grant a licence or not. Some general rules should be laid down by a proper authority for the metropolis, such as the Board of Works.

The committee adjourned to May 11th.

NOTES.

Electric Lighting in the Royal Navy.—Admiralty orders have been issued for a large number of ships to be fitted with the electric light, and preparations are being made for carrying out the work on board the vessels about to be commissioned at Portsmouth for the formation of a Baltic Fleet. A thorough overhaul is to be made of the apparatus on board the *Inflexible*, the most powerful line-of-battle ship in the British Navy, which, it will be remembered, was present at the bombardment of Alexandria, when the Egyptians were detected by means of the electric light whilst in the act of strengthening their fortifications.

Messrs. R. E. Crompton and Company have secured orders for lighting five of H.M. ships.

The Electric Light on Board H.M. Ship "Mercury."—The old apparatus not being deemed sufficiently powerful, H.M. ship *Mercury*, which is about to be commissioned at Portsmouth for the China station, is being fitted with an engine of 18 horse-power, manufactured by Messrs. Brotherhood, and one of Siemens's bar armature dynamos, to be used principally for search lights. The dynamo can, however, also be utilised for incandescent lighting, but not simultaneously with the burning of search lights. The machines are fixed in the torpedo store room in the fore part of the ship, and occupy a space of 8 feet 6 inches by 2 feet 5½ inches. The cylinders of the engine are 7 inches in diameter and 5 inches stroke, whilst one of Brotherhood's patent flexible couplings is used to connect the engine with the dynamo. The search lights are burnt on the bridge, where there are two projectors for the purpose, each of which is provided with a switch. The wires conveying the current are run through an India rubber tube. The lights are of 5,000 candle-power each, and their powerful nature would be a great advantage in case of the *Mercury* being engaged in actual warfare, and, in the present state of affairs, this is not at all improbable. The incandescent lights will be used for the illumination of the engine-room and other parts of the vessel, but, as already intimated, they will have to be dispensed with whenever it is found necessary to burn search lights. A considerable advantage has been gained by the adoption of Messrs. Brotherhood's couplings, which are so constructed that in case of any undue resistance being offered to the dynamo the couplings would part without causing any such damage to the machine as would happen under ordinary circumstances. The work is being carried out under the direction of the Chief Engineer of Portsmouth Dockyard (Mr. Albert J. Durston), and the Electrician (Mr. Lane).

Electric Lighting in Vienna.—The Imperial and Continental Gas Association, which has obtained a concession for lighting Vienna, has entrusted Messrs. R. E. Crompton and Company with the contract for supplying the requisite machinery, which will include among other things three of the largest dynamos, each capable of developing 100,000 watts at terminals. These machines will be driven direct by Willans' latest form of compound engine. Electric governors will also be used in this installation.

Ball Room Lighting.—At the ball given last week to the Prince and Princess of Wales in the Ulster Hall, Belfast, the ball-room, vestibule, staircases, corridors, and supper-rooms were brilliantly lighted throughout by electricity. The lighting of the ballroom consisted of a range of about 200 glow lamps fixed under the balcony which surrounds three sides of the hall and screened by a draping of pink tarletan. Six powerful arc lamps hung from the ceiling, enclosed in thick opal shades, and further toned down with yellow and pink muslin. A novel and striking feature was a miniature iceberg, surrounded by rare exotics, and illuminated from the interior by variously coloured incandescent lamps, giving a wonderful effect as of enormous blocks of ruby, emerald, and opal. The vestibule was also lighted by glow lamps. Underneath the staircases were ice grottoes and ferneries, studded with incandescent lamps, and, ascending the stairs on either side, the landings were transformed into "cool grot and mossy cell," the realism of which was enhanced by falls and jets of water lighted by glow lamps in frosted bulbs, some being completely submerged. In the long corridors the glow lamps again appeared in a new guise, being hung under glass shades of novel and artistic shape. The supper-room was lighted entirely from the roof by some 200 glow lamps in clusters of three under white reflectors. In the Princess's boudoir and the Prince's room electricity was still the illuminant, cut crystal brackets being used in the former, whilst in the latter the lamps were concealed in the interstices of the rockery and foliage. The entire work was carried out by the Belfast Electric Appliances Company under the superintendence of the manager, Mr. G. Annesley Grindle. It may be observed that, notwithstanding the total absence of any arrangements for ventilating the hall, the temperature throughout the evening was so pleasant as to call for universal remark, and to receive the special commendation of His Royal Highness. The power for the lighting was supplied by the engine at the Company's works, supplemented by a semi-portable compound engine, kindly lent by Messrs. Fowler and Company, of Leeds, and by a special lighting plant of Messrs. Ewart and Company, which was kindly placed at the disposal of the Company. The glow lamps (90 volt Victoria Brush) were run by Elwell-Parker 12 unit dynamo machines, and the arc lamps were the Belfast arcs, manufactured by the local company.

A temporary installation of electric light was made at Lady Hervey's residence, Hyde Park Place, last week, on the occasion of a ball. The work was carried out by the Electrical Power Storage Company for and under the direction of Mr. F. Geere Howard, of 36, Cleveland Street, Fitzroy Square. Twenty-four lamps of 20 candle-power were used, fed by twenty-four 1-H.P. E.P.S. accumulator cells placed in the area. These cells were brought from Millwall the same afternoon and returned the next morning. The lights were on 6½ hours.

Electric Lighting of French Steamboats.—A company recently organised in Paris will run a number of small steamboats (bateaux-mouches) on the Seine, thirty-two in number, which will be lighted by electricity. Each will have twenty-two incandescent lamps of 16 candle-power. The power will be furnished for each installation by a steam-engine of 5½ horse-power. The dynamo is of the Gramme type, which also supplies current for the signal light, consisting of a powerful reflector, with one incandescent lamp before it. The firm of Breguet has undertaken the installations.

B.T.K. Accumulators.—An installation of the B.T.K. system has been completed this week at the residence of Mr. S. Courtauld, Bocking Place, Braintree, where 64 incandescence lamps have been fitted, supplied from accumulators.

Important Telephone Decision in America.—In one of the Missouri courts the other day an action was brought against the American Bell Telephone Company of Missouri, by the Baltimore and Ohio Telegraph Company, to compel the former to permit telephonic communication between it and the petitioner. The telephone company's answer was that it could only extend communication to such telegraph companies as its licensor, the American Bell Telephone Company, permitted. Judge Brewer, in giving decision, said the question was whether the court could compel the defendant, doing the telephonic business of the city, and having permitted communication with the Western Union Telegraph Company, to establish communication with any other individual or company than that permitted by its license from the patentee. He held that the moment it permitted the establishment of a telephonic system that moment it put such system within the control of the State and the control of the courts enforcing the obligations of any common carrier. A telephonic system was simply a system for the transmission of intelligence and news. It was, perhaps, in a limited sense, and yet in a strict sense, a common carrier; it must be equal in its dealings with all. So his conclusion was that, notwithstanding the terms of this license, which seemed to prohibit it from dealing or giving its privileges to any other telegraph company than the Western Union, the moment it established its telephonic system, that moment it compelled itself to respond to the demands of any telegraph company or any individual in the city tendering to it equal pay for equal privileges. The application for mandamus would be sustained. The other judge, Judge Treat, differed, however. He said that if the American Bell Telephone Company refused to grant equal privileges to the telegraph company it alone should be pursued. Judge Brewer agreed that if the telephone company had refused connection with any telegraph company, the Baltimore and Ohio Telegraph Company could not insist upon such connection, but when it had established connection with one telegraph company every other telegraph company had equal rights, on the same principle that if it established connection with one lawyer it could not refuse connection with another lawyer. The reports do not state whether the judges reconciled their views, but we imagine that Judge Brewer's decision in favour of the application was sustained.

Telephonic Extensions at Glasgow.—At the last meeting of the commissioners of Pollokshields (Glasgow), it was reported by the clerk that application had been made by the telephone company to have poles erected from business premises in the city to several private dwellings in the burgh, at the request of parties engaged in the city, the company giving a guarantee to remove the poles when requested on receiving three months' notice. The commissioners, after some discussion, agreed to grant the telephone company's request.

The Telephone in the River Plate.—The number of telephones actually in use on the River Plate (in the Argentine and Uruguay Republics together) is estimated to be as follows:—Bell-Blake, 3,210; Gower-Bell, 2,120; Siemens, 600; Breguet, 250; Ader, 130; Various systems, 90; total, 6,400.

Società Telefonica Ligure, Genoa.—With regard to this company, we have received the following communication from a gentleman who has recently been in Italy :—The general meeting of the Genoa Company has just taken place ; this is the second year after the fusion of two former companies, which had fought each other long and fiercely. The company has one exchange in Genoa, and another in the neighbouring town of Sampierdarena, in connection with each other, the subscribers, at the end of 1884, numbering 803 in Genoa, and 39 in Sampierdarena. The whole capital (paid in) is 650,400 lires. The balance-sheet, without charging interest on the capital account, shows a loss of 884 lires for the past year, which proves that the subscription rate of 140 lires net is not sufficient to even cover the working expenses. This low rate has been adopted to please the public, but experience here, as with many other European companies over anxious to swell the number of their clients by any means, shows conclusively that this course only leads to ruin, a fact very hard of comprehension to the general public. If the shareholders of the Genoa Company desire ever to get a dividend, the rates will have to be raised. The same can also be said of the Turin and Milan Company, and, in general, of all Italian companies, whose affairs are far from being flourishing. The Genoa Company has a model central office, there being none other such in Italy, and even very few elsewhere in Europe. The installation is of the Gilliland system, with a capacity for 1,200 subscribers, the service going on without interruption day and night.

Proposed Increased Telegraphic Facilities for Portsmouth.—Arrangements are being made for the enlargement of the Landport Post Office by the erection of an additional storey, to be used exclusively for telegraph work. When these alterations have been completed the chief telegraph office will be removed from Portsea to Landport. The enlargement further provides for a depôt for the Royal Engineers' (telegraph section) stores, and a covered yard for the mail carts. The question of extending the hours of telegraphing has been deferred, pending the completion of this undertaking ; the only question appears to be as to whether the office shall remain open all night or close at midnight.

The Russian Telegraph beyond the Caspian.—A telegraph office has been opened at Kahka, and the *Times* supplements the announcement with a few words as to where that place is. Kahka is a Turcoman settlement about half way between Askabad and Sarakhs, being 85 miles distant from the former and 100 miles from the latter place. Kahka, which is inhabited by a small colony of the Alieli Turcomans, has been described by the late Mr. O'Donovan, in his "Merv Oasis," and by M. Lessar. This district is considered the most fertile part of the Attock. There are also several naturally strong positions crowned with ruined forts in the neighbourhood of Kahka.

"New Invention in Telegraphy." — The *American Engineer* states the following :—"A new invention in telegraphy" recently brought out in Philadelphia by George M. Hathaway and James H. Linville is said to work on the same plan as a type writer by which a novice can work the line, the message being duplicated for the benefit of the sender and received by a type writer at destination. No noise or click is made, thus securing privacy, and it is suggested that its use can be made general, not unlike the telephone. In any event, if all represented is true in regard to the merits and simplicity of the device, it has a future before it. It is in the hands of $2,000,000 capitalists.

New Stations in China.—The Eastern Telegraph Company notifies the opening of three new telegraph stations in China ; one on the Island of Hainan, called Kiungchow, or Hainan, and the others at Liemchow and Neuchang.

Malicious Destruction of Telegraph Insulators.—Last week, at the Dunfermline Sheriff Court, two miners were fined 10s. each with the alternative of seven days in jail, for wilfully breaking 29 insulators which were affixed to telegraph poles along the Great North Road between Crossgates and Inverkeithing, the property of the Postmaster-General.

Speedy Telegraphy. — A fast sending contest has recently taken place in New York, the Victor key being used. J. W. Roloson despatched 500 words in 10m. 32s., winning the first prize, $25 ; Wm. M. Gibson, 10m. 57s., second, $15, and Frank J. Kihm, 10m. 38s., third, $10.

Submarine Telegraph Cables.—In March of last year a convention was entered into between most of the nations of the world, "for the preservation of telegraphic communications by means of submarine telegraphs." This convention applies outside territorial waters to all legally established cables landed on the territories of the high contracting parties. It is here made a punishable offence to break or injure a submarine cable, wilfully or by culpable negligence, so as to interrupt or obstruct telegraphic communication. But this provision is not to apply where the breaking or injuring of the cable is done with the lawful object of saving one's own life or ship, after every necessary precaution has been taken to avoid the breakage or injury. The convention deals also with the regulations to be observed in laying and repairing cables. It imposes on the owner of a cable the cost of repairing any injury done to another cable in laying or repairing his own. On the other hand, it grants compensation to the owner of a ship who has sacrificed an anchor or fishing gear in order to avoid injuring a cable. This compensation is to be paid by the owner of the cable. The tribunals competent to take cognizance of infractions of the convention are those of the country to which the vessel belongs, on board of which the offence was committed. And prosecutions for infractions are to be instituted by the State or in its name. An important feature of the convention is that it is not in any way to restrict the freedom of action of belligerents. The convention is to remain in force for five years, and afterwards any of the parties can withdraw from it on giving a year's notice. The high contracting parties undertook to propose to their Legislatures, or to take the measures necessary for insuring the execution of the convention, and especially for punishing by fine or imprisonment those who contravene certain of its provisions. This is now done for England in a Bill introduced by Mr. Holms, M.P. By this Bill the punishment for injuring a cable is, if it be done wilfully, five years' penal servitude, or two years' imprisonment with or without hard labour, and a fine in lieu of or in addition to the penal servitude or the imprisonment. Where there is culpable negligence merely, the punishment awarded is three months' imprisonment without hard labour, and a fine of £100 in lieu of or in addition to it.

Sir Julius Vogel and the English Electrical Companies.—The *New Zealand Times* of March 9th, we learn, publishes an apology for its remarks on the telegrams received from England relating to Sir Julius Vogel's connection with the Telephone Company. The journal admits that the questions between that company and Sir Julius were of a private character, and states that it had no intention to reflect on Sir Julius Vogel's character.

Struck Off.—Among the 400 companies struck off the Register of Joint Stock Companies this week were Allan's Patent Telegraph Cable Company, Antilles Telegraph Agency, Light Cable Telegraph Company, London Telegraphic News Company, and the Spanish and Cuban Submarine Telegraph Company.

The Durability of Dynamos.—In a description of the electric lighting plant at the Prince's Theatre, which we published in our issue of the 11th inst., Mr. Berry, the electrician-in-charge, mentioned that the Siemens dynamo there used is now in as good condition as when first put down, with the exception of a slight wearing away of the commutator.

Our contemporary, the *Mechanical World*, in a short article dealing generally with the life of dynamos, and also alluding to the above, says :—"It was only a short time before this case met our attention that we carefully examined a dynamo, which was also used for a theatrical installation, in order to see what the loss had been on the commutator. It was a 250-light Edison machine, and had been constantly running for nearly 2½ years, and from the feel of the hand over the commutator, it was almost impossible to perceive that there was any wear. Applying a straight-edge it was possible to perceive that the surface had been reduced to the extent of the thickness of a piece of writing paper. As regards the brushes, these were the same as originally fixed, and would still last for a longer period. In this machine (running at 820 revolutions per minute) sparking was never observed ; the same may be said of the other Edison machines of the same type belonging to the same installation. The wear and tear of this dynamo was practically almost *nil*, and granted that it received in the future the same attention it has had in the past, it would be almost impossible to fix the limit when the occasion would have arrived to replace the commutator with a new one. The average life of a dynamo may therefore be considered to be at a high figure, provided that due care be taken of the adjustment of the brushes ; and its cost of maintenance as that of an occasional pair of brushes, and the renewal of the commutator, the cost of which would have to be spread over a number of years."

Activity in Dynamo Manufacture.—We are informed that Messrs. R. E. Crompton and Company have orders on their books for dynamos to give a total out-put of nearly one million watts.

The Institution of Civil Engineers.—The annual dinner given by the President and Council of this Institution took place on Wednesday evening in the conservatory of the Royal Horticultural Society, South Kensington, which was lit by electric lights in lamps of various colours. Overhead were four Siemens arc lights, estimated to be equal to nearly 6,000 candles each, supplied by a Siemens dynamo machine, run by the great engines of Messrs. Davey, Paxman and Co. From the same motive power the secondary batteries of the Consolidated Electric Light Company, serving 300 small coloured table glow lamps, each of 5 candle-power, were kept charged. Sir Frederick Bramwell, F.R.S., President, in his reply to the toast of the "Institution of Civil Engineers," took occasion to remark that to the engineer we are indebted for the laying on of light, or, to be more accurate, a source of light, up to the present time by means of gas, shortly, he trusted—as a light of luxury, at all events—by means of electricity. Remember, too, said the speaker, that the application of electrical science is now employed in the telephone to transmit the record of Parliamentary debates to a compositor who by means of a machine sets the type ; that distant intelligence comes from the furthest end of the world to the newspaper by the ordinary electric telegraph, and that the papers when printed are distributed by the railway throughout the country.

A Powerful Engine.—Last week there was tested in the electric department of Portsmouth Dockyard a patent compound triplex tandem engine, manufactured by Messrs. Goodfellow and Matthews, of Hyde, near Manchester, for driving dynamos, fans, or other high-speed machinery, direct. The trial proved thoroughly satisfactory. The engine is of about 19 indicated horse-power, and was found to work steadily at 750 revolutions ; but there is reason to believe that a much higher rate of speed than this could be obtained, as the manufacturers have had it running at their works at the rate of 950 revolutions. As regards the amount of steam required it was found to be very economical, and, no doubt, should a favourable report be presented to the Admiralty, the engine will be used for the production of the electric light on board ships in the Royal Navy ; in which case the small consumption of coal would be a very important consideration. It would also be found of advantage for the purpose of lighting the workshops in the dockyards during the winter time at a reduced cost.

Telephone Receivers.—We are informed that the Signal Engineering Company is manufacturing an improved receiver, and claiming that by the use of a specially-designed machine for making the membrane diaphragm, and other improvements in manufacture, the new instruments will work quite as well as Bell telephones ; in addition to which, they have not the metallic sound of the latter.

Electric Lamp Patents.—A not unimportant part in the history of incandescent lamps is contained in the specification of Frederick John Cheesbrough (Sawyer-Mann), No. 4847*, dated the 28th November, 1878. In its original form it possessed no less than 25 claims, but in its amended state these are reduced to three. It formed one of the published specifications issued by the Patent Office last week, and it may not be uninteresting to our readers if we bring before their notice that which is now claimed therein. *First.*—The herein described method of preparing the illuminating part of an electric lamp, consisting of electrically heating the same while it is surrounded by a carbon gas or liquid. *Second.*—A material for the manufacture of the illuminating conductors of electric lamps, produced by electrically heating carbon in a carbon gas. *Third.*—The hereinbefore described method of preparing the illuminating part of an electric lamp, consisting in first obtaining a solid deposit of carbon by electric action, as set forth, and subsequently when the globe containing it is charged with a carbon preservative atmosphere, before the flow of such preservative atmosphere through the lamp has ceased, and before the lamp is finally sealed, heating the illuminating part by means of the electric current, in order to expel impurities and *occluded* gases. We think that all who are working at incandescent lamp manufacture would, for many reasons, do well to possess themselves of the patent numbered as above.

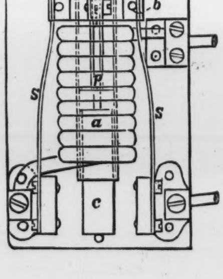
Tenders Required.—For the erection and maintenance of a telephonic wire and apparatus between the municipal offices and central police station at Blackburn and Dunsop houses, Dunsop, West Riding, Yorkshire, for the borough of Blackburn. Total length about 19 miles. Further particulars may be had on application to Mr. J. B. McCallum, borough and water engineer, Municipal Offices, Blackburn, to whom tenders are to be sent by 16th May.—*Contract Journal.*

The ss. "Dacia."—The *Dacia* arrived at Key West on the morning of the 29th ult., having encountered heavy weather in the Bay of Biscay. She called at the Azores on the 12th on her way out.

Birmingham Electric Lighting Bill.—It is understood that this bill has been withdrawn. It was promoted by the Birmingham Incandescent Electric Lighting Company, and proposed to extend and to vary the "Order" which the company obtained in 1882 for electric lighting in certain specified districts in Birmingham.

New Arc Lamps for Use with Glow Lamps.—We have received the following particulars concerning this invention from the German Edison Company (Deutsche Edison-Gesellschaft). The new arc lights can be regulated within wide limits by the strength of the current and consequently by the expenditure of power. They can be introduced like glow lamps parallel with the latter and by twos in succession in the same circuit without disturbing the peculiar steadiness and beauty of the glow lights. These lamps are for the present furnished in two sizes, one for a light equal to 300—400 normal candles with a current consumption of 3·5—4·5 ampère, the other from 800—900 normal candles with a current of 8 to 9 ampères. As two arc lights of equal size or a larger and two smaller ones are introduced in succession in the same circuit and parallel with the glow lamps, each pair of arc lamps can be lighted or extinguished by commutators independently of the others. Indeed, in an installation of many arc lights a single lamp can be thrown into or out of action. Hence it is possible with the current absorbed by three 16-candle glow lamps to supply one arc lamp and thus to obtain a light eight times more intense merely by an additional expenditure for carbons. These, according to present experience, amount at the present price of carbons to ¾d. to 1d. hourly in the small size and ½d. to ⅓d. in the large lamps. The steadiness and beauty of the new arc lamps require especial mention, as in these respects they are not excelled or equalled by any existing arc light As these properties depend essentially on the quality of the carbons employed, the company has endeavoured to procure for this purpose an excellent material which will be furnished at reasonable prices and always alike in quality. The sale price of the new lamps is to be very low in consequence of the simplicity of their construction and of the probably extensive demand at home and abroad, which admits of special arrangements for their production.

Andrews's Automatic Cut-out.—Referring to the automatic cut-out of Messrs. Cunynghame, Woodhouse and Rawson, Messrs. J. D. F. Andrews & Co. write to *Engineering* that they have been working in the same field for some time, and, giving the accompanying sketch, describe their apparatus, which has been used in a number of cases of installations on land. The coil or solenoid, A, is part of the main circuit, and is wound on a brass tube held on to the wooden base by a small bracket, B. When the current in the circuit gets too strong for the wire to carry, the solenoid sucks in the core, C, and pushes up the disc, D, by means of the pin, P, passing through the fixed half of the core of the solenoid. When the disc rises the two springs, S, S, fly out breaking the circuit very quickly without any perceptible spark. The weights, W, are to adjust the cut-out to the number of lamps in the circuit. When in use the cut-out is inclosed in a small box under lock and key. Although we have used this cut-out, say Messrs. Andrews & Co., we find the lead ones give far less trouble, as it is a rare thing when an installation is properly fitted that the fusible metal melts, but these automatic cut-outs have the advantage of allowing the circuit to be more quickly remade, and avoid the necessity of keeping a stock of replaceable material such as lead wire. We also find that this automatic cut-out is not affected by the motion on board ship.



Text Books on Electrical Measurement.—If a correspondent, "Novice," will send us his name and address his questions will be readily answered.

Promises of Prospectuses.—One of the numerous cases involving alleged fradulent representation in the prospectuses of new companies came before Mr. Justice Chitty this week. Mr. Dawson, an applicant for shares in the Phœnix Electric Light Company, now in course of liquidation, who on application paid his deposit of £50 on 500 shares, and afterwards a first call, brought his action against the company on the ground of misrepresentations contained in the prospectus, on the faith of which he applied for shares. The prospectus, of course, contained a glowing vision of future profits to be derived from the working of Fitzgerald's patents, already spoken highly of by the late Mr. Cromwell Varley, for which offers had been made. The plaintiff alleged that the persons who made the offers to the company were people of no means, and that Mr. Varley's certificate was qualified by the expression that he had not had the opportunity of submitting the invention to a test of long duration. The case had not concluded upon our going to press.

Thunderstorms.—During a heavy thunderstorm which passed over Ashton-under-Lyne on Sunday last, the cotton mill of Mr. James Kershaw was struck by lightning and set on fire, but the flames were extinguished before much damage was done. The lightning struck a chimney, passed through the roof into a spinning room, and thence into a frame room, where it ignited some loose cotton lying on a pair of pulleys.

During a thunderstorm on Saturday a farm-shed at Lower Petting, near Hebden Bridge, was struck by lightning, and three cows were killed. Telegraphic communication was interrupted by the action of the lightning.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electro Amalgamator Company, Limited.—The annual return of this company made up to the 7th inst. was filed on the 14th inst. The nominal capital is £200,000 in 40,000 shares of £5 each. 31,461 shares have been taken up and the full amount has been called and paid thereon, the paid up capital amounting to £157,305. Since the previous return 791 shares have been issued.

Australasian Electric Light, Power and Storage Company, Limited.—The annual return of this company, made up to the 13th of January, was filed on the 21st ult. The nominal capital is £255,000 in £5 shares. Upon 24,000 ordinary shares £4 per share has been called; 6,000 ordinary shares are fully paid up, and 1,000 founders' shares are also fully paid up. The calls paid amount to £129,560 5s., and unpaid to £1,439 15s. As compared with the previous return the paid up capital shows an increase of £22,810 5s. Registered office, 41, Coleman Street, E.C.

Anglo-American Brush Electric Light Corporation, Limited.—An agreement, dated 16th ult., and filed with the documents of this company on the 21st, authorise the allotment of fully paid up shares in pursuance of agreements dated 28th and 29th of last

November, made with the Great Western Electric Light Company, Limited, and the Brush Midland Electric Light Company, Limited.

Change of Office.—The registered office of the Deal and Walmer Electric Light Company, Limited, is now situated at Middle Street, King Street, Deal.

CITY NOTES, REPORTS, MEETINGS, &c.

Indo-European Telegraph Company, Limited.

THE eighteenth ordinary general meeting of this company was held at Cannon Street Hotel, on Thursday, Colonel James Holland presiding.

Mr. Andrews, managing director, having read the notice convening the meeting,

The Chairman moved the adoption of the report, which has already been published in the REVIEW. He said: When we last had the honour of meeting you it was my agreeable duty to mention that the past year had been an uneventful one—a kind of year that is always satisfactory to shareholders. I am glad to be able to report that the year just past, 1884, has also been an uneventful one. There is one circumstance attending it that is to be regretted, namely, that commercial affairs have been very stagnant all over the world, and as the result of that there has been a reduction in the amount of net earnings to the amount of about £1,000. It would have been greater, but we have managed to make up the revenue from other sources. There is also another reduction to report, but one which will not very greatly grieve you, namely, a reduction in the expenditure. That is to say, it is about £1,500 less than the expenditure of the preceding year; and when we consider that not only have the wires been kept in far better order than they ever were, no expense having been spared in keeping everything in perfect order, and that we have also laid out £2,000, our share of laying a new cable across the Straits of Kertch, I think you will admit that as regards the special management of our friend, Mr. Andrews, nothing could be more satisfactory, for it is to his untiring zeal and intelligence that we owe this considerable reduction instead of what might have been expected—an addition. I can assure you that not a week passes but his mind turns to the improvement of our means of communication, and to show the extent that they have been improved I may mention that the average time from London to Teheran is now 15 minutes, and to Constantinople not more than half-an-hour—but over the latter line we only go as far as Odessa. It is impossible almost that any system of telegraphic communication could be more perfect than ours. Included in the items of importance, we have also leased a second wire from the India Office. The German Government, on our communicating that fact to them, with the greatest promptitude placed a second wire on their system also at our disposal, from Emden, the nearest point on the coast, to Berlin, so that we have a two-wire communication the whole way to Teheran. There is also, when it is in perfect working order, two-wire communication from Teheran to India; that portion of the line is under the management of the Indian Government, and I wish I could say it is as perfect as our own, but it fails occasionally, and does not keep up the same degree of excellence that we have managed. But the repair and renewal, whenever requisite, has been taken in hand by the very energetic head of the Indian Government Telegraphic Department; and as the Indian Government generally is unwilling to allow measures to slide—generally acts with energy and promptitude—we have every hope that that portion during the year will be placed in as good a condition as our own. I should say that we owe the addition which the German Government has made to our line greatly to the good offices of that very able and energetic minister, His Excellency Dr. Von Stephan, who has lately been ennobled by the Emperor of Germany in recognition of his merits. We were fortunate in having so able and efficient a Minister at the German Court. There is little else to mention to you excepting one point—that perhaps you will observe that we carry over a larger sum than usual. We carry over, instead of a few hundred pounds, a sum of upwards of £4,000. I think that requires no special comment; we all know what the state of political affairs is at present, and we deem it essential in our interests that we should have a good sum to carry over, for no human being can foretell at what moment events may require everything we possess in the way of reserve. Our regular reserve fund, which now amounts to £51,385, is a very great sheet anchor. That fund and the insurance we possess in the joint purse agreement with the Eastern Telegraph Company are of inestimable value to us. It would be indiscreet, as no doubt you will understand, for me to dilate upon the existing state of political affairs. We all know what danger may accrue, and all we can say is that we have lost no opportunity amongst ourselves of endeavouring to safeguard your interests. With that remark I will conclude. I move that the report and statement of accounts be received and adopted.

Mr. H. Weaver, a director, seconded.

Mr. Matthews enquired whether, in the event of their system being interrupted, the joint purse arrangement would still continue.

The Chairman: The agreement respecting the joint purse gives us a very valuable insurance of our property for a certain time. We have no cause to specify, but we calculate that should any disturbance occur, and last no longer say than twelve months, our loss will not be very material.

The motion was then put, and carried unanimously.

The Chairman moved the declaration of a dividend for the past six months of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 10s. per share, both free of income tax, making in all 8 per cent. for the year.

Mr. J. H. Tritton seconded.—Carried.

Messrs. C. W. Earle and J. B. Gossler were re-elected to the board, and the auditors, Messrs. Kemp, Ford & Co., were reappointed.

A vote of thanks was then accorded to the Chairman, and the proceedings terminated.

Eastern Extension, Australasia, and China Telegraph Company, Limited.

THE 23rd ordinary general meeting of this company was held at the Cannon Street Hotel on Wednesday, Mr. John Pender, M.P., chairman of the company, presiding.

Mr. F. G. Hesse, Secretary, having read the notice convening the meeting,

The Chairman, after stating the financial position of the company as set out in the report, published in the REVIEW last week, said: During the year we have renewed, to the extent of 789 nautical miles, our brass-ribboned cable. The amounts taken from the revenue for this purpose being, for the first half of the year, £22,767; and for the past half year, £20,000. Up to the present we have renewed with brass-ribboned cable about 1,500 miles, and there are still from 600 to 800 exposed to the teredo, and which will have to be renewed when opportunity occurs. I am glad to say we have no interruptions, but we are very seldom without them, and therefore we have to prepare for them. The principal interruptions have been at the Penang, Madras, and Java stations. The traffic, however, was not apparently affected, as it was transmitted by the company's alternative lines. The same remarks, however, cannot be made with reference to the interruptions between Tasmania and Victoria; and, unfortunately, great inconvenience has been caused to the telegraphing public of those colonies. Your directors, with the view of giving as reliable communication as possible, have decided to duplicate the line. This will be carried out, when a favourable opportunity occurs, with cable taken from our stock at Singapore. Our Foochow station, which I referred to last time I had the pleasure of addressing you, is now open. We had a good deal of negociation with the Chinese Government, and it fortunately ended in our having our station at Foochow with landlines to Sharp Peak, which gives us a perfect service, kept entirely in our own hands. Now, gentlemen, perhaps the only really dark shadow that has come across our progress since we have become a company has been the loss of our steamship, the *Magneta*. I mention this as the first subject, because probably it has caused a greater amount of pain and sorrow to many even outside this board, and I think it right to refer to it rather in a more prominent manner. We after a good deal of experience decided to build two ships. One ship was built for this company, another was built, on precisely the same lines, for the Eastern Telegraph Company. Both ships received an amount of consideration that probably is not often given to ships. They were of a technical character, and were literally floating workshops, and every part of each ship had to be considered in regard to strength and in regard to the particular work which the ship had to do. I may mention that the care that was exercised was such that when the ship was completed the excess over the contract, the extras, only amounted to about £24. I think that is a thing unexampled. I believe there is no evidence of such care in all the details as was shown in the building of that ship. I may also mention, in regard to the ship, that your directors visited her, and every one was loud in praise of its efficiency. The captain told me the night before it sailed that he did not believe there ever was a ship so well suited for the work as the *Magneta*; he was proud of his ship, and thought he would be able to give a very good account of her when she was brought into active service. So confident was he in his belief in the safety of the ship, that though he was urged the day before he sailed to insure his life, he refused to do so. I mention these details to show you that your directors took every possible care to equip the ship so that it should be in every respect efficient. I may mention, in conclusion, that the ship was fully insured. We shall repeat the ship. But I require some little expression of sympathy on your part, for it will be necessary perhaps for your directors to say something more than words of sympathy to some of the families for the losses they have sustained. I cannot point out any particular case, and we only want an expression of sympathy and approval, that we may be able to deal with the matter with delicacy, with prudence, and, I think, with satisfaction to the shareholders, for any expenditure in this way will be such as I am sure, looking to all the circumstances, a flourishing company like ours ought not to grudge. (Applause.) Our cables are all in working order: how long they will be so it is difficult to say. I have had a great many enquiries as to what is to be the position of our cables in the event of war. (Hear, hear.) Well, gentlemen, we have got altogether 36,000 miles of submarine cable. It is very difficult to protect that cable. However, we have submitted to the Government our views, and we think, as cables are not only becoming a necessity for political communications, but above all things for commercial communications, that it is just as necessary that we should have protection for our cables as that mercantile ships should be protected from privateering and from any attacks of the enemy. How far it is possible to carry that out it is not for me to say. All that I can say is this, that we shall have our repairing ships at the proper places—the places where we consider they ought to be in the event of any breakages, and I think our position will be such, and the necessity for maintaining our cables such, that the Government will see it of vital importance to give us such protection as we may require. In regard to the working of cables in war time, there is an old saying, "It is an ill wind that blows nobody good." There is no doubt that it does increase our traffic largely. War is about as good a thing for the time being for increasing traffic as there can be, because the messages are not measured by words—they are long and continuous. We have carried, I believe, our traffic during war time so satisfactorily to the Government that I feel, whatever may occur, we shall not be wanting in the mode of doing our work, nor be wanting in returns in the way of traffic. It is scarcely necessary for me to go further into details at the present time. It is a very critical time, and we are watching your interests in the very closest way possible, and looking to the very successful report which we have put before you to-day, looking to the increase in our reserve fund, and looking to the growing necessity for telegraphic communication, I will only add that during war I see every reason to look forward to a large traffic. I hope the war will be short if it does occur; and if it does not, I think, looking to the general depression which has prevailed, in a great measure arising from the uncertainty as to whether there will be war, that with peace, if really and substantially established, we may look forward to a very considerable change in trade. Trade gets sick at times, but it never dies, and I think the position of Great Britain as a trading nation is such that when trade revives we shall have a very large share of it, and the telegraphic companies will be the first to feel it. I beg to move, "That the report and accounts of the directors, now submitted, be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 2s. per share, both free of income-tax, payable on the 30th inst., making, with the previous distributions, a total payment of 7 per cent. for the year 1884."

The Marquis of Tweeddale seconded the motion.

A Shareholder asked how many persons were on board the *Magneta*.

The Chairman replied that there were 54 in all, including some young men they were sending out to stations, electricians, and one or two men who were going out to China for the purpose of erecting tanks for the company; they were all men connected with the company in one way or another.

Mr. Newton remarked that, supposing war occurred, and their cable was cut, would they be able to charge higher rates, and to charge war rates for the messages. He thought they should have some such protection as the insurance companies had.

The Chairman stated that they were not bound in any way, but he thought it would not do for him to say that they should make any alteration in their tariffs. They must wait, and be guided by circumstances. Their first consideration would be to do their service well, and next, that in doing it well the shareholders would be benefitted.

The resolution was then put and carried unanimously.

Sir Thomas Fairbairn and Mr. C. W. Earle were re-elected directors, and the auditors, Messrs. Deloitte, Dever and Griffiths, and Messrs. Quilter, Ball & Co., were re-appointed, the proceedings thereupon being brought to a termination with the usual vote of thanks to the directors.

The Oriental Telephone Company, Limited.

THE fifth ordinary general meeting of this company was held at the Cannon Street Hotel on Tuesday, Mr. William Addison presiding. The report of the directors for the year ending December 31st last, which was submitted to the meeting, stated that the profit and loss account resulted in a credit of £3,242 19s. 9d., after including the dividends accrued on shares held in the subsidiary companies; and proceeded:—"It has been deemed advisable to charge this account with the full liabilities incurred in respect of guarantees to the Bombay and Bengal companies, and the amount of £9,082 6s. 7d., now appearing to debit, represents the guarantees to 31st December last. The foregoing sum embraces, in the case of the Bombay company, a period of 18 months from the 1st July, 1883, and in the case of the Bengal Company of 19 months, from 1st June of the same year.

"A further important item charged to this account is the difference between the nominal market value at the end of the year of the 'A' shares held in the Bengal Telephone Company, and the price at which they were valued in the balance sheet for 1883.

"Against these sums debited as above, the following items have been transferred from the balance sheet of last year to the credit of profit and loss account:—£7,000 entered as a reserve fund, £8,426 0s. 5d. profit on sale of the Bengal Exchange, and a further sum of £1,000, being one-half of the amount, reserved last year in respect of estimated depreciation of the Egyptian indemnity award.

"The indemnity award amounts to 200,000 francs, which will, it is hoped, be received very shortly, and so strengthen the available funds of the company.

"The balance remaining at credit of profit and loss is £3,945 1s. 1d., which it is proposed to carry forward to meet current guarantees and possible further depreciation of assets.

"No new exchanges were opened in the year under review, but one is in course of construction at Moulmein, to which considerable support has been promised, and it is anticipated a small income will be derived therefrom during the current year.

"The opposition which has existed in Calcutta has been removed. This we trust will greatly benefit the Bengal company. There has been a fair increase in the number of subscribers, to both that and the Bombay company's exchanges, during the year.

"The Telephone Company of Egypt has added 90 to its number of subscribers, and the shares held in that company have been taken into account at the same valuation as last year.

"From Shanghai the accounts received from the agent are very promising, in spite of the unsettled state of China. The books of the China and Japan Company have not yet been made up, the final accounts not having been received.

"As the shareholders have so recently had placed before them the report of the committee of investigation, the directors do not think it necessary to make any further statement regarding the affairs of the company.

"The call of one shilling per share, made payable on the 10th ultimo, has been received to the extent of £9,600, leaving £1,400 still due.

"The loan of £5,000 from the bankers has been paid off."

The Secretary, Mr. Chalmers, having read the notice convening the meeting, the report was taken as read, and the Chairman moved its adoption. He said: some shareholders might think that because nothing very disastrous to the company was disclosed in the report of the committee of investigation that the report was unsatisfactory. He begged to say that he thought quite the contrary. He was very glad that they had nothing more serious to show. They now all knew the position of the company very much better than they did before, and that it was not in a hopeless condition, as many of them had feared. Many shareholders doubtless felt great anxiety as to the liabilities of the guarantees on the Indian companies. The amount this company would be liable for in that respect during the next three years, taking the revenue of those companies at what they were at present, would not, they thought, exceed about £10,000, and only under circumstances so bad as to prevent their being able to realise any of the shares they held in the subsidiary companies, except on such terms as the directors would not feel justified in accepting, would a call of 1s. per share be necessary, and that would more than meet the whole of those liabilities. The contingent liability, to which reference was made in the balance sheet, was a long outstanding claim of Mr. Leggatt, who was their agent in India in promoting the subsidiary companies there. This had now been compromised on terms favourable to the company. The subscribers to this company's exchanges, and those of the affiliated companies, numbered 1,568 in 1884, as against 1,148 in 1883; this year, up to the latest dates, the additions showed an increase of 115, representing an addition to this year's revenue of upwards of £1,000; that was for a period of three months. The directors proposed to limit their fees for 1885 to £500.

Mr. Grewing seconded the adoption of the report.

A Shareholder having asked several questions relating to the accounts,

The Chairman said the directors considered the amount by debtors, £13,625, was good. About £8,000 was due on the Egyptian Indemnity, and the bulk of the rest represented what was due to them from the subsidiary companies.

Mr. Robinson Kendal asked whether, in the event of the arrangements of the subsidiary companies proving successful, the directors had any hopes of getting the 1s. per share back again.

The Chairman said that was the amount (£10,000) they would be liable for if the working of those companies remained as at present; if it improved, the amount of their liability would be reduced by the amount of the improvement. Replying to a further question, he said the claim of Mr. Leggatt was reduced by nearly two-thirds.

Mr. Adams, who stated that he was Mr. Leggatt's solicitor, said no doubt Mr. Leggatt's claim was considerably larger than the amount he received, but, on the other hand, the company alleged that they had a cross claim, and to a certain extent that cross claim was admitted. He advised Mr. Leggatt that it would be better, perhaps, to accept the sum offered than to go into litigation with a powerful company. When litigation commenced there was a new board of directors, and no doubt, while many circumstances connected with the claim affected the individual members of the old board very considerably, they did not affect any gentleman now on the board. They could have fought the case through without fear that any facts would come out that affected them individually. He did not say that any of the old directors would have necessarily suffered in reputation by the disclosure of any of those facts, but there were certain points in connection with Mr. Leggatt's claim which did not apply to the new board. He thought these were sufficient reasons why Mr. Leggatt would not be very wise in fighting a company like that under such circumstances.

The Chairman: I do not think that affects the correctness of my statement.

Mr. Adams: No, it does not affect its correctness, but it does affect the inference to be drawn from it.

Mr. Hall (the late secretary of the company) said he was pretty familiar with the circumstances, and he was sorry that Mr. Adams had hinted that there was anything the old directors did not wish to be known. As a fact, they did suggest a compromise, which was refused at the time, but which had since been accepted, to the advantage both of Mr. Leggatt and the company. He did not think it quite fair to gentlemen not present for Mr. Adams to say anything which affected the reputation of those gentlemen.

Mr. Robinson Kendal remarked that although the accounts were not so favourable as they could have wished, yet, under all the circumstances, he thought there was every hope of a future for this company. In one respect the shareholders were fortunate in having the report of the committee of investigation before them—not because he thought they had discovered anything, nor because he thought they had discovered what they thought they would discover—but because they had before them now an exact statement of the position of the company at this moment. If they put aside that injudiciousness of management to which all men were liable, and left out also that after-wisdom for which all men were celebrated, they must come to the conclusion that there was nothing in that report which seriously affected the old board. Personally he had no doubt of it. The chairman, one of the directors, and the secretary, had assured him that there was nothing wrong in the affairs—there might be a few errors of judgment, but nothing more, and their statements were amply verified by the report of the committee. It was not advisable to hark back to past affairs of the company; they knew its present position, and he thought there was every hope of a prosperous future.

The motion for the adoption of the report was then put and unanimously agreed to.

Messrs. Deloitte, Dever and Griffiths were re-elected auditors, at a reduced remuneration, upon their own suggestion, of 50 guineas.

The meeting then terminated.

The Brazilian Submarine Telegraph Company, Limited.

THE report and accounts of the directors for the half year ended 31st December, 1884, is as under:—

The revenue for this period amounted to £89,385 3s. 11d., and the working expenses to £21,851 2s. 1d. (including £8,737 6s. 0d. for repairs of cable). After providing £8,066 13s. 4d. for debenture interest and sinking fund, and £1,005 14s. 4d. for income tax, there remains a balance of £58,461 14s. 2d.; to this is added £331 2s. 4d., brought forward from 30th June last, making a total of £58,792 16s. 6d. First and second interim dividends amounting to £39,000 have been paid, and £17,000 transferred to the reserve fund, leaving the sum of £2,792 16s. 6d. to be carried to the next account.

Since the last general meeting two interruptions of the company's cables have occurred; one was caused by a ship's anchor disturbing the new Madeira-St. Vincent cable on the 28th November, and the other, which took place on 3rd January, in the old St. Vincent-Pernambuco section, was due to friction upon a reef. The repairs were effected on the 18th December and 19th February respectively, the regular transmission of traffic having been in no way interfered with. All the company's cables are now in good working order.

The Direct United States Cable Company, Limited.—The directors have resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ending March 31, 1885, payable on and after the 16th of May.

The West India and Panama Telegraph Company, Limited.—The directors have decided to place £8,000 to reserve, and to recommend to the shareholders at the approaching meeting that a dividend of 6s. per share be declared on account of arrears of dividend on the 1st preference shares.

The British Spiral Telephone Wire Syndicate, Limited.—Creditors are required on or before June 12th to send their names and addresses, and the particulars of their debts or claims, to William Downie, of 28, Southampton Buildings, Chancery Lane, the liquidator of the company.

Eastern Telegraph Company, Limited.—This company has announced the payment by interest warrant on the 1st inst. of interest for the half year ending April 30th on the 4 per Cent. Mortgage Debenture Stock.

London Platino-Brazilian Telegraph Company, Limited.—A final divinend of 1s. 9d. per share, free of tax, is announced for payment on and after the 11th inst.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 24th were £2,515, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

PROCEEDINGS OF SOCIETIES.

Physical Society, April 25th.

Prof. GUTHRIE, President, in the Chair.

THE following papers were read: "On the Theory of Illumination in a Fog," by Lord RAYLEIGH. The paper dealt with certain theoretical results based upon the assumption that the medium in which the fog was formed and the substance composing the fog itself were perfectly transparent. The effect of such a fog surrounding a source of radiation would be to diminish the radiation, and in the case of a supply of energy from without, as with the carbon filament of an incandescent lamp, the temperature of the source would be increased by the fog. A spherical envelope of such a fog surrounding the lamp and sufficiently thick to be impervious, would act as a perfectly reflecting surface. A problem closely related to the above and which is easily worked out, is that of light incident normally upon a pile of glass plates. If m be the number of such plates and ρ the fraction of incident light reflected by one plate, $\phi(m)$ the light reflected, and $\psi(m)$ that transmitted by a pile of m plates, we have

$$\frac{\phi(m)}{2m\rho} = \frac{1}{1 + (2m - 1)\rho} = \frac{\psi(m)}{1 - \rho}$$

If the transmitted light be allowed to fall upon another pile consisting of n plates, we have an infinite amount of reflection between the plates, and as the final result, if A denotes the radiation in the original direction and B that in the opposite

$$A = \frac{2n\rho + 1 - \rho}{2(m + n)} \qquad B = \frac{2n\rho}{2(m + n)\rho + 1}$$

If m and n are large, we have $A = B = \dfrac{n}{m + n}$

which shows that by increasing n we can make the radiation between the plates as much as if the first pile did not exist, whatever the number of plates in it.

"On a Monochromatic Telescope," by Lord RAYLEIGH. This is a modification of Maxwell's colour box. In this instrument, as is well known, light passes through a slit in the focus of a collimimating lens, it traverses in succession this lens, a prism, and another lens by which it is brought to a focus upon a plane surface in which is a movable slit; the eye being placed behind which receives light approximately monochromatic. If, in addition, a lens be placed just behind the first slit so as to bring some distant object into focus at a convenient distance from the eye, this object will be seen by the light that would enter the eye in the simple colour box. The author suggested the use of this instrument to compare lights of different colours, and hinted at the possibility of chosing some colour towards the middle of the spectrum at which lights might be compared for practical purposes.

"On the Self-regulation of the Compound Dynamo," by Prof. A. W. Rücker. If ϕ represents the current or electromotive force in the external circuit of either form of compound dynamo it is given by means of an equation of the form

$$\phi = \frac{P}{A + x} - \frac{Q}{B + x}$$

where A, B, P and Q are quantities which are different in different cases, but are always independent of the external resistance, and x is the conductivity or the resistance of the external circuit, according as ϕ represents the E.M.F. or current. The constant, A, in all cases depends only on the resistance of the various parts of the machine.

If μ and m are respectively the largest and smallest values of x between which self-regulation is aimed at, then $\mu - m$ may be called the *range of* x. That value of x which corresponds to the resistance most frequently used may be called the *usual value* of x, and indicated by ξ.

The maximum efficiency, η, of the machine is connected with A and ξ by the relations

$A = \xi(1 + \eta) / (1 - \eta)$ if ϕ be the external E.M.F.

$A = \xi(1 - \eta) / (1 + \eta)$ if ϕ be the external current.

It can easily be shown that the function, ϕ, has two critical values, and that the value of x corresponding to one of these is necessarily negative, unless one of the inducing spirals is wound so as to diminish the magnetisation.

Various cases are considered corresponding to different relations among the magnitudes of the constants, A, B, P and Q. The following indications of the method of treatment may suffice. If $A/B < 1 < \sqrt{P}/\sqrt{Q}$ ϕ is positive for all positive values of x, and the critical value of ϕ occurs for a negative value of x, so that ϕ diminishes as x increases. Hence, if we write

$$\frac{P}{A + m} - \frac{Q}{B + m} = \phi_1$$

we must have

$$\frac{P}{A + \mu} - \frac{Q}{B + \mu} = \frac{\phi_1}{1 + q}$$

where q is a positive quantity which will be less as the self-regulation is more perfect. These equations give

$$\mathrm{P} = \frac{\phi_1}{1 + q} \cdot \frac{\mu - m - q\,(\mathrm{B} + m)}{(\mathrm{A} - \mathrm{B})\,(\mu - m)}\,(\mathrm{A} + \mu)\,(\mathrm{A} + m)$$

$$\mathrm{Q} = \frac{\phi_1}{1 + q} \quad \frac{\mu - m - q\,(\mathrm{A} + m)}{(\mathrm{A} - \mathrm{B})\,(\mu - m)}\,(\mathrm{B} + \mu)\,(\mathrm{B} + m.$$

Now since $\mathrm{A} - \mathrm{B}$ is negative, we must, if P and Q are positive, have

$$q > (\mu - m) \,/\, (\mathrm{A} + m)$$

and *a fortiori* $$q > (\mu - m) \,/\, (\mathrm{B} + m)$$

By similar methods inferior limits to q are found in other cases, and it is thus shown that for given values of μ and m the limit is lower as A is larger. It has, however, been proved above that if the maximum efficiency of the machine is high, A will be large or small according as it is taken from an expression that gives the external E.M.F. or the external current. Hence it is more difficult to combine high efficiency with good self-regulation if an approximately constant external current is desired than if an approximately constant external E.M.F. is aimed at. The equations do not lead to any simple rules for the relations which should hold between the various parts of compound dynamos, but if some of the constants are taken as given, the values which must be assigned to the others can be calculated if a given efficiency for the usual value of x and a given deviation from perfect self-regulation between given values of x are to be attained.

"On the Determination of the Heat-capacity of a Thermometer," by Mr. J. W. **CLARKE**. The method consists in the estimation of the masses of the mercury and glass of the thermometer immersed by weighing the instrument in air and in water and again in water when immersed to the extent usual in the thermal experiment. The specific gravity of the glass and mercury being known, the absolute masses immersed can be readily calculated and consequently their thermal capacity.

A photometer which enabled a comparison to be made between the light of a lamp emitted at any angle and a standard was exhibited by Mr. **DIBDIN**, and the action explained by Mr. **LIVINGSTONE**, who stated that the maximum amount of illumination took place at an angle of 45°.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, April 23rd. Mr. C. E. **SPAGNOLETTI**, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new, and proposed new, members, announced, the discussion on Mr. Oliver J. Lodge's paper on "The Seat of the Electromotive Force in a Voltaic Circuit" was carried on.

Prof. **FITZGERALD** said: On the whole, I entirely agree with the actual position Dr. Lodge has taken up, as I think it explains what most likely takes place, but at the same time I do not agree with his opinion that his position is definitely proved by actual experiments. I do not agree with him in thinking that the Peltier effect is the same thing as the Volta effect—as the electromotive force between two metals. He has given an illustration which, however, I do not agree to represent the state of affairs. I think that there are no experiments that are able to decide where the seat of electromotive force is, and it is quite possible that, as Mr. Gibson said in Montreal, the question is one which is undecidable, and that when we know really where any electromotive force exists, we may not have to ask *where* it is, because it may be everywhere—in the whole of space, for the matter of that. If we had two vessels, zinc and copper, placed beside one another, then in that case there is in their position nothing to cause a difference of pressure between the two. To illustrate any attraction between the zinc for electricity and copper for electricity we may suppose the zinc vessel to be higher than the copper vessel, then I represent the force of attraction of the zinc for electricity and copper for electricity by the gravitation of the earth, producing a difference of pressure between the two vessels. If we suppose that there is a little paddle-wheel in the pipe joining the two vessels capable of winding up a weight, or producing heat, which only comes into existence when the current is running (and it is only while the current is running, as I conceive it, that the Peltier effect has any existence), then the movement of the wheel represents the Peltier effect. It has no existence at all except while the current is running, and it is only then that the wheel is being wound up, or is being unwound. It will be seen that the Peltier effect is quite a different force and different nature from the contact force between the difference of pressure which is produced by the contact of zinc and copper. If you can illustrate the effect by the arrangement indicated, it shows it is almost certain the Peltier effect is one of quite a different kind from the contact. In fact, the Peltier effect depends on the *rate* of variation, on the *rate* of difference of potential, and not on the difference of potential itself. I do not think Maxwell was right in saying that the heat developed in the Peltier effect necessarily measures the rise of potential in the poles. Prof. Lodge has been misled in his analogy.

Professor **PERRY** said that Dr. Lodge is the exponent of the views held by Clerk-Maxwell, but he himself would look at the question from what may be called the Thomson side. Dr. Lodge accepts the contact theory of voltaic action, he acknowledges that the electromotive force of a voltaic circuit is equal to the sum of the contact forces, as measured electrostatically, of the various substances when in contact. He says it is absurd to imagine that there is a considerable difference of potential between two metals, say zinc and copper, in contact with one another. He says: "Yes, experimenters have certainly found an apparent difference of potential, they have measured apparent differences of potential; these are due to an air effect." Yet they have measured these differences of potential, when, instead of air being the dielectric, there have been other gases quite different from air, but still he says they have obtained the same effects as before. They have even measured these differences of potential in perfect vacuum, but still Dr. Lodge says it is an air effect. Not only does he say that this is the case, but that if you could obtain as perfect a vacuum as has been obtained by Crookes, and obtained the same results as we supposed, it might still be due to an air effect. It is quite obvious that Dr. Lodge must have some very strong reason for his discarding evidence, because in Brown's experiments there really were salts formed on the metal. I consider that the seat of the E.M.F. in a voltaic circuit has really nothing whatever to do with difference of potential between zinc and copper in contact; and, in fact, that Dr. Lodge's paper has not got quite the proper title. Dr. Lodge gives, in two quotations from Clerk-Maxwell, the definition of E.M.F., and the definition is not merely the definition of E.M.F., but is the definition of the seat of the E.M.F. The seat of the E.M.F. in any circuit is the point at which the circuit receives or gives up energy as distinct from that due to resistance, and the amount of the E.M.F. is measured as the amount of energy which enters the circuit per unit of electricity passing in that point. Now, how is it possible, with a definition of E.M.F. like that, to give an answer to Dr. Lodge's statement, that the seat of E.M.F. is practically at the point where the chemical action goes on? It follows, if the point where the chemical action goes on is the seat of the E.M.F., that the E.M.F. of a voltaic circuit can be calculated from the chemical actions going on. But Dr. Lodge's paper takes up a very different matter. He finds reasons for believing that there cannot be a considerable degree of difference of potential between zinc and copper at the contact. We have never stated that there is an E.M.F. due to contact between zinc and copper. We deny that there is such contact E.M.F., but we do say there is contact difference of potential. We do not say that what has been measured is not to some, even a large, extent due to air effect, but we contend that no such air effect has ever been observed, obtained, or noticed. We cannot admit that there is any strong reason for believing in its existence. Dr. Lodge says if the electricity rises in potential from copper to zinc, there must be a supply of energy from some outside source at the point of contact. Now, we ask him why? We do not ask him what amount, for he says "that electricity rises in potential at the point of contact." Does he mean there is a rise of potential inside a wire in which a current is flowing, or is he speaking of electrostatic potential? Does he assume that there is the same potential at different points of cross-section in a wire or nearly the same potential? He cannot answer these questions, in our opinion, unless he knows what is the distribution of electricity through the copper mass. Now, considering that we do not know whether it is a trillionth of a unit of electricity per cubic millemetre, or whether there are trillions of units of electricity per cubic millemetre, and considering we do not know whether there is any electricity in the body of the wire, we believe these questions stand in the way of any logical proof such as Dr. Lodge supposes he can make. We are willing to assume that, in taking count of electricity at a point in a section of the wire to the outside and from that through the dielectric and from that into the wire to a point in another section, the work that must be done is the sum for any two points in the same section, as Dr. Lodge assumes, and to take that work as the definition of difference of potential between these two sections; but still we ask him why we must assume that when electricity rises in potential suddenly at a place in a circuit energy must come in from outside to enable that rise of potential to take place? Suppose we grant that electricity gains in potential energy in flowing from copper to zinc, do we know so much of an electric current as to assert that when the electricity gains potential energy it does not lose an equivalent quantity of some other kind of energy? Why may we not assume, for example, that electricity loses tension energy in passing from copper to zinc, so that if it gets potential energy it loses tension energy, and that in that case part of the potential of the liquid in the cell would be taking electricity from the zinc to the copper inside the cell giving tension energy, and that tension energy is converted into potential energy when electricity passes from the outer part of the circuit from copper to zinc? But why should we assume that work must be done by outside agents at a point in raising electricity from potential A to potential B? But the definition of difference of potential between point A and point B is work carrying electricity through from A to B. It does not, however, follow that you must do work by an outside source in carrying electricity from point A to point B through the wire itself. We know so little of what is meant really by the electric current, and the mechanical analogies which have been put forward from time to time are so imperfect, that I always like to fall back upon the old and simple one, and this oldest and simplest one is this: When electricity is flowing in a copper wire there is electricity in every part of the wire and not merely on the outside of it. Now, at one end—the battery end—of this copper wire, electricity is thrust in at the zinc to the copper wire, and in consequence at the other end, where the copper joins the zinc, there is a tendency for electricity to leave the copper and enter the zinc, just for the same reason that electricity tries to come to the outside of bodies repelling the electricity from itself. If at the zinc end electricity can only get away by rising in tension, it rises in potential, but the energy at B which becomes potential energy comes from A, the battery end. It is not necessary to get a supply of energy from an outside source to B. When we speak of electricity flowing through a wire we are using an idea which is derived from electrostatic statements to explain a phenomenon of an electro.dynamic kind. If Dr. Lodge objects to the idea of tension energy, even to the idea of tension, we can tell him in spite of our very exact knowledge of mechanics, we have the same sort of difficulty in many mechanical arrangements. For example, supposing you have a winding engine and a long endless rope passing over pulleys, horizontal in places, vertical in places, and coming back to the engine again, and at one place there is a weight being lifted. Now, work is being done on that weight in lifting it. But energy does not come from the motion of that circuit; it comes from the winding engine; it comes somehow through the rope. Energy disappears at the winding engine, and appears as work done in the weight being lifted. In what form is it before it is converted into work—before the work is done? It is our idea of this thing that the energy is conveyed. In what form is it when it is in the rope? We really do not know. I mean to say we have not given a name to it. The best thing to fall back upon is the idea of tension-energy. All we know is there is a difference in the tension of the rope above and below the weight being lifted. Difficulties of the kind I speak of—such difficulties as will prevent Dr. Lodge from speaking of tension-energy—are really due to the fact that the notion of conveyance of energy from one point to another has not yet been co-ordinated with the ordinary exact definition of energy. But the analogy which I like best, and which in every particular, in every detail, satisfies the voltaic circuit, is the hydraulic analogy. Suppose we have a circuit filled with an incompressible fluid such as water, and the pipes are of uniform section, and at a certain place there is a sudden rise in level. There may be various rises of level at various places, and suppose we have continuously-acting pumps acting in some portion of the circuit. Now mechanical energy disappears in that pump, and thus enables a continuous circulation of water to go on. Thus, for example, in rising from one point to another water will really gain energy, that is, there is a gain of potential energy; it is raised in level. Now what has it lost? It has lost no form of energy, it has lost pressure. There is a greater pressure at the upper point than at the lower point. It is well known that in such a circuit as that, in any stream of steady incompressible fluid, the velocity in feet per second of the water at any point remains constant. Now this really represents the potential energy of a point of water, supposing it could give us that energy according to the level, and this represents the energy of the pound of water; and we are clearly entitled to say that this also represents a form of energy, and the thing means that the total energy of a pound of water is constant at any point in the stream. But we find there is no such thing as pressure energy in an incompressible fluid. It is only on condition that you have a steady stream that this may be regarded as a form of energy, and people are rather familiar with the idea of calling it pressure-energy. But it is only when you have it continuously and steadily acting in some part of the circuit that you may regard it as a form of energy. Now, just as difference of potential in electrical things is measured as the work done, the electricity in flowing out from one point to another through the dielectric has a difference of level to represent the work done in a pound of water running from one point to another. But this is not merely an analogy. It really represents the true state of things in a voltaic circuit. There is a tendency for electricity to leave copper and enter zinc at the junction. We are prevented from calling this the E.M.F. of contact, so we will call it contact force. It is measured as the difference of potential is established in the two metals which are in contact. There is no contact force in a piece of copper or in a piece of zinc. The contact force is analogous with the pressure in water. A sudden rise in level in the pipe corresponds with the sudden increase of potential from copper to zinc. There is a consequent diminution of pressure from one point to the other. This corresponds with the contact force at the junction. There is no contact force in a copper wire. It is necessary to give to the pipe such an inclination that the potential energy lost by the water in flowing along the pipe shall be equal to the energy given out in friction. In the voltaic circuit similarly the fall of potential energy is known to be equal to the loss of tension energy—to the heat produced in overcoming resistance. We agree with Dr. Lodge that the seat of E.M.F. as defined by him is a place where the chemical action goes on. There is no seat of E.M.F., however, at the junction of zinc and copper, but there is a difference of potential, which carries electricity through the dielectric from one place to another—from copper to zinc—work must be done. But it does not follow that to make the electricity flow from copper to zinc in the metal itself that an outside circuit needs to do work. This is analogous with the water case. To carry one pound of water from one point to another through the air, it is necessary for an outside source to do a certain number of foot pounds of work upon it. But when one pound of water flows through the pipe no work is done by outside agencies on the water. The potential energy which the water has gained in passing we must say has come from the pipe. If we are to consider what is the form of energy which is converted into potential energy before water comes to the higher point, we are forced to say it is pressure energy.

Dr. Hopkinson thought that Dr. Lodge's explanations were the most satisfactory ones on the subject that had yet been given,

(To be continued.)

NEW PATENTS—1885.

4989. "Compound coupling for the electric conducting wires of railway carriages." H. J. Haddan. (Communicated by H. Lippmann.) Dated April 22.

4992. "Construction and arrangement of electric lamps and lamp fittings." T. T. Smith. Dated April 22.

4993. "Mode of, and means for lighting houses and other structures by electricity." T. T. Smith. Dated April 22.

5001. "Voltaic cell or battery element." J. D. F. Andrews. Dated April 22.

5005. "Electric meters." H. Watt. (Communicated by E. Weston.) Dated April 22.

5006. "Electric meters." S. F. Walker. Dated April 22.

5013. "Utilisation of electricity for the transmission and distribution of power and apparatus therefor." H. Watt. (Communicated by E. Weston.) Dated April 23.

5045. "Galvanic batteries." T. J. Jones. Dated April 23.

5061. "Electro magnets." Sir D. L. Salomons. Dated April 23.

5069. "Secondary or storage batteries." G. E. Dorman. Dated April 24.

5093. "Protecting lightning conductors from the action of atmospheric acids and other destructive influences." T. Massingham. Dated April 24.

5106. "Method of subduing or modifying light, more particularly applicable to incandescent electric lamps." A. J. Littleton. Dated April 24.

5117. "Telephonic apparatus." R. Theiler. Dated April 24.

5120. "Electrodes for secondary batteries; forming same." M. H. Hurrell. Dated April 24.

5123. "Exciting field-magnets of series-wound dynamo machines." W. H. Allen, R. Wright, G. Kapp. Dated April 24.

5143. "Electric arc lamp." F. Fenton. Dated April 25.

5147. "Electric arc lamp." J. G. Statter. Dated April 25.

5201. "Induction apparatus for transforming electric currents. C. D. Abel. (Communicated by C. Zipernowski, M. Déri and O. T. Bláthy.) Dated April 27. (*Complete.*)

5202. "Galvanic batteries." A. Schanschieff. Dated April 27.

5208. "Facsimile or autographic telegraphy." P. B. Delany. Dated April 28. (*Complete.*)

5212. "Alphabetical electric telegraph instruments." R. C. Williams. Dated April 28. (*Complete.*)

5218. "Fire telegraph system." L. H. McCullough. Dated April 28. (*Complete.*)

5219. Non-interfering fire alarm telegraph system." L. H. McCullough. Dated April 28. (*Complete.*)

5225. "Electric arc lamp." H. Trott, C. Fenton. Dated April 28.

5231. "Braiding machines applicable expressly for covering electric conductors with asbestos. H. Botten. Dated April 28.

5235. "Telephone transmitters." J. E. Fuller. Dated April 28. (*Complete.*)

5256. "Voltaic batteries." A. R. Bennett. Dated April 28.

5258. "Protecting vessels from torpedoes by means of magnets." C. R. Parkes. Dated April 28.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

6590. "Improvements in telegraphic apparatus." R. K. Boyle. Dated April 19. 6d. Relates to telegraphic apparatus which is intended particularly for submarine cables, or for a system of telegraphing in which alternate, positive, and negative electric impulses are sent over the line.

6646. "Improvements in the construction of secondary voltaic batteries." H. F. Joel. Dated April 22. 6d. The inventor constructs the electrode plates of the battery with any suitable metal, metal alloy, or material, combined or otherwise with any suitable oxide, or salt. He makes what is known as the negative electrode, viz.:—The plate bearing the peroxide, or what may be termed the depolarising electrode of one material, and the positive electrode of the same, or of dissimilar material, or he may use and combine different metals in one electrode. He finds that the addition of any suitable metal such as tin, zinc, or an alloy with which a local electrical action is set up with the lead, keeps the lead from becoming coated by an insulating coating of sulphate, or other salt; an alloy of lead and tin is especially suitable. The E.M.F. of lead and tin and their alloy is so close that but a slight action takes place, and thus the alloy, whilst serving the purpose, will last for a long time, especially if amalgamated with mercury.

15583. "Improvements in telephones." C. A. DAY. (Communicated from abroad by J. Lowth and W. D. Ewart, of America.) Dated November 26. 6d. Relates to improvements in the apparatus described in specification 15582.

16178. "Improvements in mechanical attachments for use with incandescence electric lamps." R. P. SELLON. Dated December 9. 6d. The attachment consists of two parts, the cap shown partly in section in fig. 1, and the socket also shown partly in section in fig. 2. The cap (fig. 1) is generally made out of a short length of round piping of metal, wood, or other suitable material. This cap is fastened, as shown in fig. 1, to the incandescence lamp by means of plaster of Paris, or other suitable cement of electrically insulating properties. The cap (fig. 1) is made of such a size as to enable it to freely slide into the socket (fig. 2). Through the cement, *a*, are lead wires, *b*, b^1, electrically connected to the terminals, *c*, c^1, of the incandescence lamp, to suitable contact pieces, which project slightly from the bush, *e*, as shown. These contacts, *d*, d^1, are mounted at a convenient radial distance, as shown in fig. 2, from the axis line of the attachment, on the insulating bush, *e*, and in the sides of the cap are suitably fixed one or more pins, *f*, f^1, as shown, which serve to secure the tubing to the bush, *e*. The socket (fig. 2) into which the cap slides is preferably made of metal tubing, to which is attached a cap, *g*, which is fastened by any convenient means, preferably employing a "female" screw, to the bracket or fitting for carrying the attachment. For mechanically fastening the cap (fig. 1) to the socket (fig. 2), the inventor employs the well-known "bayonet joint" connection, and for this purpose he cuts one or more slots, *h* (fig. 2) in the sides of the socket. In the slot or slots, *h*, is cut a notch, *i*, so that when the cap is given the full quarter turn employed in making the joint, the pin or pins, *f*, *f* (fig. 1) above referred to, in the sides of the cap bed into the notch, *i*, and the cap can only be removed from this position by hand. In one of the ends of the socket is fixed a bush, *j* (fig. 2), and to avoid complication, the screws, *l*, l^1, are arranged not only to fasten the bush, *j*, to the cap, *g*, but also serve to fasten the cylindrical or tube portion of the socket, *m*, *m*, to them. In the bush, *j*, are drilled two holes, *n*, n^1, preferably parallel to the axis line of the attachment; through each of these holes is brought one of the conducting wires, connected to the source of electricity. The object in employing two holes is to prevent contact between the wires in the fitting, and to enable the employment of two holes; the bush, *j*, is made removable. These conducting wires are fastened by means of the pins or screws, *o*, o^1, which serve both to secure the springs, *p*, p^1, to the cap, *g*, and to fasten or bind the wires to the springs, *p*, p^1.

FIG.2.

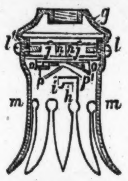
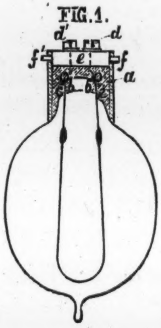


FIG.1.



16276. "Improvements in voltaic batteries." D. G. FITZGERALD and T. J. JONES. Dated December 11. 4d. According to the invention the inventors employ as a support for the depolarising agent a conductor, such as a plate of lead or silver, which is itself susceptible of oxidation, but which is coated with a first or superficial but dense coating of peroxide of lead, which is preferably rendered impervious by means of a suitable non-conducting substance such as paraffin-wax (which should be free from stearic acid) while permitting contact of the depolarising agent with such first coating. Such a conductor becomes equivalent for the purpose in view to a plate of gold or platinum, insomuch as this first impervious or nearly impervious layer of peroxide constitutes an inoxidisable conductor which protects the oxidisable conductor from contact with the electrolyte, and thus obviates local action. In carrying out the invention the inventors first obtain a superficial layer of peroxide of lead upon the surface of any suitable rigid conductor of oxidisable metal or of carbon, preferably by making such conductor the anode within an electrolyte, composed for instance of a solution of oxide of lead in caustic alkali, the peroxide being allowed to deposit very slowly. The first superficial layer thus obtained may advantageously be burnished or subjected to pressure between smooth plates or rollers; it may then be supplemented by a second thin coating of peroxide of lead. Other electrolytes, such as a solution of lead nitrate, dilute sulphuric acid, or a solution of sulphate of magnesia, may be employed. When, however, the acid or the sulphate solution (or any electrolyte which does not contain lead) is used, the conductor must be lead; the plate must in this case be maintained in the electrolyte until oxygen is evolved from its surface, when it should be removed, washed with water, dried, and pressed or burnished. It should then be returned to the electrolyte until oxygen is again evolved from its surface, when it is washed and dried a second time. The conductor thus coated with inoxidisable conducting material may now be more completely protected from contact with the electrolyte, when in use, by immersing it in melted paraffin-wax (or similar waterproofing substance) until the layer of peroxide of lead is saturated with this material. The latter when cold is carefully removed by means of a scraper, or other suitable tool, from the surface of the plate, so as to expose the conducting peroxide of lead of which the pores will remain filled with the paraffin. The prepared plate when used may be immersed in a pasty mass of peroxide of lead with water, a solution of sulphate of magnesia or other suitable fluid, such pasty mass, alone, or in admixture with carbon fragments, being contained within a porous receptacle; or this receptacle may be dispensed with, and the prepared conductor may be utilised as a support for a comparatively thick and porous layer of peroxide of lead obtained by any of the known means, alone, or in admixture with carbon fragments. In this case the element may be wrapped in canvas, felt, or other suitable porous material.

16840. "Improvements in telephone receivers." J. E. FULLER. Dated December 23. 4d. The invention consists of a multipolar magnet composed of several pole pieces of a given polarity arranged in a group around a central re-entrant pole piece of opposite polarity, said first mentioned pole pieces being attached to or integral with a disc or base, or arms radiating from a common centre, which forms the base of the re-entrant pole.

CORRESPONDENCE.

Prof. Ferraris on Secondary Generators.

I enclose a copy of a letter I have just received from Prof. Ferraris. I avail myself of his kind permission to send it to you, because I know that it will be most agreeable both to him and me that it should be known that we are agreed upon this matter.

Prof. Ferraris is in no way in fault. The mistake has arisen from my not being sufficiently explicit.

J. Hopkinson.

April 28th, 1885.

[COPY.]

Turin, *April 26th*, 1885.

Dr. J. Hopkinson, F.R.S.

Sir,—I thank you heartily for your letter of the 21st instant, in which you give me explanations in regard to the method you adopted in determining the efficiency of the secondary generators of Gaulard and Gibbs. Your account, which I read in the *Electricien* of Paris (1884, April 15th, page 344), the only one which you had published, only said that your measures were done by means of a quadrant electrometer by the method followed some years ago by M. Joubert, in Paris, and this caused me to believe that you had calculated the energy absorbed by the secondary generators by multiplying the mean difference of potential by the mean strength of the current. M. Gaulard had besides strengthened my opinion so that I thought it unnecessary to write directly to you in order to ask information.

Therefore I was innocently induced to put down your name amongst those of the experimenters who inexactly interpreted their experiments. The explanations you now kindly give me in your letter convince me that I have misunderstood you, which makes me very happy, because I like very much not to be at discord with a man of science whom I esteem highly. You have done well in publishing your letter in the journals in which abstracts of my paper have appeared. I authorise you to do the same with the present if you think that it is convenient.

(Signed) Prof. GALILEO FERRARIS.

Re-winding Dynamos.

In your issue of the 25th inst. Mr. Moon deals with my former communication in a manner which need not be here characterised. The method is peculiarly his own, and by this time your readers will know how to value his utterances. The personal observations which Mr. Moon delights to convey in bad grammar and in still worse taste may be dismissed at once as unworthy of serious comment, while his arguments—if indeed they may be so called—can be refuted in a few words.

In the second paragraph of his letter Mr. Moon says that the figures I give in example 2 are not in accordance with his formula. Were this statement correct it would simply prove his formula to be wrong, but as it happens, in the present instance, the value 20·4ω which I gave for the magnet resistance is the same as the value obtained from Mr. Moon's first equation $R_1 = \frac{L^2}{R}$. I have not compared the others as it would not gratify me in the least to know whether my figures do or do not correspond with his formulæ; enough that they fulfil the condition that the same amount of work shall be expended in both the field-magnets and armature as in the series machine. Calling E the E.M.F. at terminals and C the total current in the series machine corresponding to the current in the external parts of the circuit in the shunt machine and maintaining the same meaning as before for the other symbols, we have for the shunt field-magnet resistance

$$R_1 = \frac{E^2}{C^2 R}$$

and for the armature resistance

$$r_1 = \frac{C^2 r}{\left(C + \frac{E}{R_1}\right)^2}$$

Mr. Moon says to produce the work given in example 2 it is necessary that the resistances of the armature and field-magnet should be ·085ω and 15ω and not ·087ω and 20·4ω as given by me. These figures of Mr. Moon's are utterly wrong. Instead of having 490 watts expended in the armature and a similar amount in the magnets, Mr. Moon would have 498 watts in the armature and 666 watts in the magnets, making a total of 1,164 watts instead of 980 as in the series machine. Evidently Mr. Moon's vaunted familiarity with algebra serves him badly here.

Mr. Moon, happy in the complacency of his own convictions, goes on to say that in example 3 the resistance I give is too great to properly excite the magnets. Now Mr. Moon ought to know that the excitation given to the magnets depends upon the number of convolutions, and that by varying the gauge of the wire we may have any number of convolutions and consequently any excitation we please, keeping the resistance unaltered. In his letter, the order of things that ought to maintain in dynamo designing is exactly reversed, for if a shunt dynamo having the same armature is to have the same efficiency as a series dynamo, the resistance of the shunt magnets, R_1, must be obtained from the equation

$$C^2 (R + r) = \frac{E^2}{R_1} + \left(C + \frac{E}{R_1}\right)^2 r$$

and this determined we do not require to fit a resistance to the dynamo as Mr. Moon thinks, but we choose a gauge of wire to suit both the required strength of field which can be obtained from the characteristic, and the resistance which may be found from the above equation. We do not *discover* a value of R_1 but we *determine* a value of R_1, which is quite a different thing, and having determined this we choose a gauge of wire which will give the *correct* result, and *not* an internal expenditure of work invariably higher than what we want.

Mr. Moon endeavours to make an absurdity of my statement that *the internal work in any dynamo depends upon the sum of two quantities without reference to the individual values making up this sum*; but here, I think, he is again singularly unfortunate. "The two quantities are independent," says Mr. Moon, "and neither may be changed without the one varying as a function of the other." Precisely, and the whole object of our formulæ is to determine the relative resistances and windings, so that the one shall be the particular function of the other, which will enable us to fulfil certain predetermined conditions. Having settled what the ratio between the work done in the magnets and that done in the armature shall be, we determine the windings accordingly, and it will be obvious to most minds that the total work expended internally depends only on the sum of the two quantities irrespective of the ratio they may bear to each other. This fact is not influenced by saying that altering the ratio alters the sum or *vice versâ*.

In conclusion—secluded as it is behind a veil of erudition and learned references—it is possible to see in the last paragraph of your correspondent's letter the shadow of an admission that there may be more than one way of reconstructing a shunt dynamo to fulfil the conditions laid down. Doubtless this shadow will become substance when the thick haze of mathematical pretension which at present obscures Mr. Moon's vision shall have cleared away.

W. B. Esson.

April 26th, 1885.

Ruddle's Cut-Out.

The cut-out referred to by your correspondent "L" in last issue was designed to provide this company with an efficient cut-out at a low price and without any intention of revolutionising the electrical world. I have no recollection of the Sawyer-Man design to which he refers, and would point out that by using terminal screws to clip the fusible wire a burnt out plug may be renewed without either carrying round soldering tackle or having a supply of spare plugs.

M. Ruddle, A.S.T.E. & E.

Manchester, *April 28th*, 1885.

To Shunt a Series Dynamo.

I have recently shunted three series-wound dynamos for Mr. Swinburne, using for that purpose a rule he gave me. Seeing that there is some difference of opinion expressed in your pages with regard to this matter, it may be of interest if I briefly give his method, as it is very simple, and needs no calculation. It is based on this, that, *with a bobbin of given dimensions, with or without an iron core, the magnetic effect or number of ampère turns is constant when the area of the bare wire varies inversely as the E.M.F. on the ends of the bobbin, whatever be the thickness of insulation on either wire.* The ease with which alterations in winding can be made by this will be best shown by an example (taken from practice).

Given a 20 ampère series dynamo: it was required to give 60 volts as a shunt machine at full load. It was assumed that the dynamo was properly designed in series, so that the ampère turns were correct on both armature and field. Now a departure from these conditions means spoiling the efficiency. The machine was run at a random speed of 1,200 revolutions per minute. Resistance was put in the external circuit till the current was 20 ampères, the normal current. Again the E.M.F. varies with the speed, the current being constant. The differences of potential at the brushes and field terminals were then taken, and gave respectively, in round numbers, 50 and 10 volts. As a difference of potential of 60 volts was required, the magnets were wound with wire, the copper area of which was one-sixth that of the series wire, and the pulley was replaced by one raising the speed to 1,440 revolutions per minute. Thus a shunt machine was obtained giving 60 volts and 20 ampères in the armature. The external current was of course slightly less, *i.e.*, by the amount of the shunt current. The only measurements taken were the differences of potential between the brushes and the field terminals, the speed, the current, and the diameter of the copper of the wire. The magnets of course heated more than with the series winding, for the number of watts varies inversely as the volume of copper. This, however, is unavoidable, for a shunt dynamo is less efficient than a series one of similar dimensions.

This method seems to me to be the most practical solution of the problem. It enables one to disregard the insulation and volume of copper, saves counting the ampère turns or measuring the resistance; and, providing the area of the bare wire is properly chosen, the magnetic effect will always be constant. The increase of heat and alteration of efficiency will give no trouble in ordinary cases.

Marcel Deprez's law is, I think, inapplicable to this particular case, for the magnets of series dynamos are too small to take the increased volume of insulation entailed by using finer wire.

Next, consider the case in which the speed and E.M.F. at the terminals of machine are kept constant, and let the armature be rewound. Here it is obvious that since the E.M.F. on the brushes is too high, if the field be kept constant, the number of turns of wire on the armature must be reduced.

Assume a hypothetical dynamo in which the wire has no insulation, or insulation proportional to copper, so that the power with a given number of ampère turns is always the same. By first winding the magnets in shunt to give the same ampère turns with the new E.M.F., and then winding the armature with fewer turns to give the sum of the shunt and main currents at the required E.M.F., viz., the original terminal E.M.F., a machine could be designed giving the desired results. But, as insulation is not proportional to copper, the matter is really rendered very complex. In fact, calculations that assume there is no insulation are practically useless.

Rewinding the magnets with thinner insulated wire lowers the efficiency of the dynamo; increasing the area of the armature wire raises the efficiency. If the net result of such alterations be to lower the efficiency of the machine, there would seem to be any number of solutions of the problem, the only limit being the heating of the magnets or armature, or arrival at the point of maximum output. Again, if the alterations can, as a whole, raise the efficiency, there are two solutions giving the same efficiency as before, one on each side of the best solution. But why rewind armatures, when the result desired can be easily got by altering the speed a little?

Albion T. Snell.

36 and 37, Bermondsey Street,
April 28th, 1885.

"The Varley Electric Patents Proprietory."

From a notice which has lately appeared in your journal, I see a circular has been issued inviting the public to take shares in a company registered under the title at the head of this letter. As I find, from the above company calling themselves the Varley Proprietory, many suppose I am associated with it, I must ask you to allow me through the medium of your columns to say I am neither now, nor have I ever been, associated with it in any way. I find from an inspection of the documents at Somerset House and the Patent Office, that the joint inventors, patentees, and vendors are Mr. Beale, a confectioner, Mr. Shearer, an accountant, and Messrs. Padbury and F. H. Varley.

If this company had registered themselves under the title of the F. H. Varley Patents Proprietory it would perhaps have been more straightforward, as he is the only Varley connected with it, and he happens also to be the youngest member of the family.

Although I would have preferred in this letter not to have written anything which might seem to be passing an opinion as to the value of the inventions of the so-called Varley Patents Proprietory, still as I have read the agreements, and looked over some of the patents, I feel it right to make a few observations; and if these partake to a certain extent of the nature of criticism, I think the company, seeing the title they have assumed, will have no real right to complain.

The company's circular contains the following paragraph:—

> The company's patent carbon is an entirely new departure, and possesses advantages over carbons made by any other known process. When manufactured in sufficient quantity its cost is infinitesimal, the bye-products almost covering the cost of manufacture; and its economy in consumption is considerable, whether it be used as battery plates, electrodes for arc lamps, filaments for incandescence lamps, diaphragms for electro-chemical and other filters, packing for steam engines, or the infinite variety of purposes for which it is available. Apart, therefore, from its value to electrical engineers, it is likely to be in great demand by manufacturing chemists, sugar refiners, brewers, and generally in connection with the arts and manufactures.

The patent specification describes the electric light carbons as being made of twisted or plaited string, cord, bobbin, or gimp, and the battery carbons of solid or thick woven fabrics, such as solid woven cotton or flax driving bands. First the fabric is stretched on a frame and submitted to the action of caustic alkali, it is then washed and dried and submitted to the action of sulphuric acid; after this it is again rinsed, dried, and soaked in a hot solution of petroleum, or other suitable hydrocarbon. The fabric so treated is then placed in a chamber or retort capable of standing a considerable degree of heat. This chamber has an airtight lid, and is provided with an inlet and an outlet pipe for the circulation of a stream of coal gas or a hydro-carbon vapour, which is caused to flow through during the time this carbonising chamber is heated for charring the fibres and converting them into conducting carbon.

The specification further states: the rods or bars thus produced are removed from the chamber whilst warm, and again immersed in the liquid hydro-carbon until the cells or pores are filled, when they are replaced in the carbonising chamber and re-heated, and by a succession of heatings and immersions the cells become filled with conducting carbon.

The above description is a condensed abstract of the specification of the patent. Your readers will be able to judge for themselves whether electric light carbons made in the manner described, with the comparatively expensive materials employed, and whether battery plates made from such an expensive material as thick woven driving bands, can be made at "infinitesimal" cost, as stated in the company's circular. It would be interesting to know what are the valuable bye-products obtained during the process of carbonisation, which, it is stated in the circular, nearly cover the cost of manufacture. The patent specification, from which I have made a condensed abstract, makes no reference to any bye-products being obtained, nor does a subsequent patent taken out in 1884, in which further applications of the patent carbon are claimed.

If this company can manufacture carbon suitable for sugar refiners as well as for electrical purposes, at an "infinitesimal cost," notwithstanding that the materials used are comparatively costly, and the process of carbonisation a very elaborate one, they may, I think, well claim to have made an "entirely new departure."

There is another matter which I feel I ought to call attention to. The patentees receive a certain amount of fully paid up shares as payment for their inventions with the exception of Mr. Beale, who appears from the deed to receive nothing for his share in the patented inventions.

It is intelligible enough that the company should pay the vendors for their patents; but what is not so intelligible is that Mr. J. T. Carrington, who is not a vendor, but is described in the deed of agreement as a journalist, is allotted 565 fully paid up £5 shares—£2,825—and for which in the deed of agreement he appears to have given no value. Some explanation to those intending to take up shares, giving a reason for allotting shares to the value of £2,825 to a director of the company, would seem to be desirable.

S. Alfred Varley.

2, Hamilton Road, Highbury,
April 27th, 1885.

PATERSON & COOPER,

ELECTRIC LIGHT AND POWER AND TELEPHONE ENGINEERS,

ST. PAUL'S WORKS—76, LITTLE BRITAIN, LONDON, E.C., AND
EUROPEAN TELEGRAPH WORKS—POWNALL ROAD, DALSTON.

Prize Medals, International Electrical Exhibitions, Paris, 1881, London, 1882, and Calcutta, 1883.

MANUFACTURERS OF

DYNAMO MACHINES ARC LAMPS, AND ALL ACCESSORIES FOR ELECTRIC LIGHT INSTALLATIONS.

DYNAMOS.—PATERSON & COOPER'S Phœnix Dynamos for Incandescent or Arc Lighting; Slowspeed Machines for Ship Lighting; Dynamos for Electro-Deposition of Metals.

SEARCH LIGHTS.—Submarine Arc Lamps for Salvage or Fishing.

ENGINES.—High Pressure and Condensing; Steam Boilers; Turbines, Water Wheels, Overshot Breast and Undershot; Shafting, Pulleys, Plummer Blocks, Gearing, Belting, &c.

ARC LAMPS.—Licensees and Manufacturers of the Clarke-Bowman Arc Lamp, the Pilsen Arc Lamp, the "J.F.," and other lamps.

INCANDESCENCE LAMPS.—Agents for Swan, Edison, Bernstein and other incandescence lamps.

MEASURING INSTRUMENTS.—Cardew's Universal Voltmeter, Paterson's Patent Electro-magnet Am and Voltmeters, and Engine-room Ammeters; Ayrton & Perry's Am and Voltmeters, Ohmmeters, Powermeters, Tachometers, &c.

CARBONS.—"WALLACE DIAMOND" Carbons, as used at Severn and Mersey Tunnel Works, Great Western Railway Company, International Health Exhibition, &c.; HARDTMUTH'S SOFT CORE CARBONS.

FITTINGS.—Sockets, Holders, Lamp Reflectors, Brackets, Improved "R.E." and Maynard Switches; Safety Cut-outs, and all requirements for electric light installations; Cables of all descriptions.

TELEGRAPH INSTRUMENTS.—Telephones, Switchboards, Magneto Call Bells, "S.N." Instruments, Railway Signal and Speaking Instruments, Tapper Bells, &c.

EXPLODERS & TORPEDO GEAR.—Admiralty and Mackenzie Firing Keys; Fuse Exploders for Blasting.

Engineering and Electrical Work of all sorts carried out. Estimates and Specifications for Electric Lighting free of cost.

ELECTRIC LIGHT LEADS, GUTTA-PERCHA, INDIA-RUBBER COMPOUND BRAIDED COTTON, SILK-COVERED WIRES.

SPECIAL WIRES FOR DYNAMO MACHINES

PHILLIPS BROS.,

ELECTRICAL WIRE MANUFACTURERS,

THE LEA TELEGRAPH WORKS, HACKNEY WICK,

LONDON,

FORMERLY OF

MACINTOSH LANE, HOMERTON.

ESTABLISHED 1870.

SPECIAL WIRES FOR INCANDESCENT LAMPS

GERMAN SILVER WIRES FOR HIGH RESISTANCES, FLEXIBLE CORDS, TELEPHONE WIRES, &c., &c. MULTIPLE, AERIAL, AND SUBTERRANEAN CABLE WIRES TO ANY SPECIFICATION.

INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH WORKS COMPANY, LIMITED.

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Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS AND MANUFACTURERS
OF

CABLES.—Submarine, Subterranean, and Aerial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Inkers, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's, and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHE BATTERY, which has received the most favourable reports from the Postal Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office and English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

Manufacturers of the most Improved Apparatus for RAILWAY BLOCK SIGNALLING.

SEMAPHORE REPEATERS, "LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

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